Rampion Offshore Wind Farm

ES Section 2b – Onshore Project Description

RSK Environmental Ltd | **Document 6.1.2b**

December 2012 | **APFP Regulation 5(2)(a)**

Revision A

E.ON Climate & Renewables UK Rampion Offshore Wind Limited

CONTENTS

Tables

Figures

2B PROJECT DESCRIPTION (ONSHORE)

2b.1 Introduction

2b.1.1 The following sections describe the proposed works associated with the onshore components of the Rampion Offshore Wind Farm (the Project). These include:

- The landfall – the area from mean low water springs (MLWS) where the four offshore transmission cables come ashore and will be jointed onto the onshore underground transmission cables;
- The onshore underground transmission cables – which are required to deliver electricity generated by the offshore wind farm to the National Grid transmission system; and
- A new onshore substation and associated cabling – required to facilitate connection to the National Grid transmission system at the existing Bolney substation.

2b.2 The Project

Onshore Definitions

2b.2.1 Throughout this ES a number of terms are used to describe different geographic areas and sites relating to the onshore components of the Project, which are those located landward of the mean high water springs tide line (MHWS).

2b.2.2 The "Project site" forms the boundary of all possible development associated with the Project. The onshore aspects (Development Area) comprise the following areas:

- "Landfall": the area between the mean low water springs tide line (MLWS) and the transition pits (between offshore and onshore cables), of which the area between the mean high water springs tide line (MHWS) and the transition pits is considered part of the Onshore Project for the purposes of the EIA;
- "Cable route": the corridor within which the onshore transmission cables will be routed for the Project; and
- "Substation site": the area within which the onshore substation and associated equipment connecting into the existing National Grid Bolney substation will be located.

2b.2.3 The Development Area, comprising all temporary and permanent works, is shown in Figure 2b.1.

2b.3 Onshore Cable Route

2b.3.1 The proposed onshore cable route is approximately 26.4km long and is described below. It is proposed that the cables will be installed underground for the entire route and trenching will be the primary construction methodology employed. At sensitive crossing locations the working width will be reduced as far as practicable.

2b.3.2 The selection and refinement process of the proposed route, which established a route between East Worthing - where the offshore export cables will make landfall - and a new substation to be located close to the existing National Grid Bolney substation, is described in Section 3 (Alternatives).

2b.3.3 The proposed route for the onshore transmission cables is shown in Figure 2b.1; this is the route that is the subject of this ES and has been split into eight distinct sections for clarity and to aid assessment (see Figure 2b.2).

Cable Route Sections

Section 1

2b.3.4 Where the cable comes ashore at the landfall location between East Worthing and Lancing, the offshore cables will be drilled using a Horizontal Directional Drill (HDD) technique, under the beach, the sea defences, the A259, and the national cycle route which runs parallel to the coast before connecting to the onshore cables at the transition bays at a location within the pitch and putt course at Brooklands Pleasure Park. The onshore cable route will continue through parts of the Pitch and Putt and Par 3 Golf Course. This area forms part of a former landfill site and is currently owned by Worthing Borough Council. Special measures will be implemented to ensure that the introduction of the cabling does not lead to a risk of environmental pollution due to release of contaminants from the former landfill. Comments from Worthing Borough Council have been taken into account in refining the cable alignment in this area to minimise the disruption to these amenities. A maximum of two of the Par 3 greens may be impacted and will be reinstated to the same condition as prior to the works. The cables will then cross the northern boundary of the golf course and continue in a northwest direction adjacent to the Southern Water sewage works. The cable route overlaps with part of the We Cycle Too cycle track, where temporary restrictions will be required, but will be subject to full reinstatement. A number of trees with Tree Preservation Orders (TPOs) are located in the vicinity of the Brooklands Park Pitch and Putt and Par 3 Golf Course. The cable route then continues in a north westerly direction through an area of amenity grassland. It then passes through an area of mixed plantation woodland and into a disused and overgrown former allotment area located immediately south of the railway line.

Section 2

2b.3.5 The cables will be directionally drilled beneath the railway and head north. Having crossed the railway, the cables will continue in a northwesterly direction through a series of flat and low lying pastoral fields and cross a number of field drains, but avoiding the new Teville Stream channel alignment being constructed by the Environment Agency. The route then passes west of the historic Decoy Farm landfill site located on the eastern extent of Broadwater. The route then continues northwards through agricultural land, crossing Upper Brighton Road and a public right of way south of the A27. The cables will then move towards the A27 Sompting Bypass where they will be directionally drilled under this major road.

Section 3

2b.3.6 Once north of the A27 the cable route enters the South Downs National Park and heads generally north east through pastoral fields to the east of Lambleys Barn. The cables cross a number of public rights of way in this section.

Section 4

2b.3.7 In this section the cable route continues north, passing south east of Beggar's Bush before turning in an easterly direction north of Steep Down. The route avoids Steep Down Site of Nature Conservation Importance (SNCI) and also avoids a Scheduled Monument (cross dyke) at Steep Down. Applesham Farm Bank SNCI has also been largely avoided by the cable route through rerouting; however a small corner of the SNCI falls within the proposed working area.

2b.3.8 Directly north of Steep Down the cable route crosses the intersection point of a number of public rights of way, and crosses a public right of way northwest of Applesham Farm. The cable route then approaches the River Adur south of Upper Beeding disused cement works and quarry.

Section 5

2b.3.9 The cables will be directionally drilled beneath the River Adur, the footpath along the eastern bank of the river, a national cycle route and Steyning Road (A283). From this crossing, the cables will travel northeast through agricultural land across Mill Hill Road where the route gradually ascends towards Beeding Hill.

2b.3.10 On the northern side of the River Adur the cable route crosses in proximity to Old Erringham Farm Valley and Road Cutting SNCI and an adjacent unnamed area of Ancient Semi-Natural Woodland (ASNW). The working area on the northern side of the River Adur crossing will be located within Old Erringham Farm Valley and Road Cutting SNCI, however the temporary land take will be restricted to the semi-improved neutral grassland at the base of the valley and will not encroach on the chalk grassland embankments either side of the valley or the ASNW to the south of the valley.

2b.3.11 The cable route continues in a north-easterly direction towards Beeding Hill and west of the Truleigh Hill radio transmission tower. The cable crosses a number of recreational routes including Monarch's Way and the South Downs Way National Trail while avoiding the Beeding Hill to Newtimber Hill SSSI.

2b.3.12 The cable then turns in a westerly direction onto Tottington Mount and continues across the ridge of this hill before crossing the summit and descending down the slope. The alignment of the cable is routed in a sinuous loop which reduces the gradient and allows the route to negotiate the steep, north-facing chalk escarpment.

2b.3.13 By avoiding the Beeding Hill to Newtimber Hill SSSI, and due to the Truleigh Hill topographical constraints, the cable crosses a Scheduled Monument (cross dyke) at Tottington Mount. The working width will be reduced to the practical minimum in this area.

Section 6

2b.3.14 From the base of Tottington Mount the cables will be routed in an easterly direction through agricultural land immediately south of Edburton Road. The route turns northwards towards the northern boundary of the South Downs National Park and towards the Low Weald and the settlement of Woodmancote. The route crosses several local footpaths which connect Edburton to the neighbouring settlements of Small Dole and Woodmancote.

2b.3.15 Within this section, the route passes through generally open farmland and avoids nearby ecologically sensitive sites such as Tottington Wood SNCI, Horton Clay Pit SSSI, Tottington Wood LNR and small pockets of ASNW.

Section 7

2b.3.16 Continuing northwards, the cables will cross the A281 at a point between the town of Henfield and Woodmancote Place. It then heads north, crossing several footpaths between Henfield and Blackstone, and runs between several areas of ASNW including Woodhouse Wood.

2b.3.17 The route continues north towards Twineham across low lying land, crossing a small watercourse and then loops east to avoid residential properties and other physical constraints before crossing the B2116 road.

Section 8

2b.3.18 From the B2116, the cables will head directly north between the settlements of Wineham in the west and Twineham to the east, avoiding built heritage assets in the form of listed buildings at Twineham Place and Great Wapses Farm.

2b.3.19 Through this section, the route passes close to, but will avoid, Paddock Wood ASNW. The route crosses the young River Adur and one of its tributaries, and passes through predominantly agricultural land, before crossing Bob Lane and terminating at the new Rampion onshore substation that will be located due east of the existing Bolney National Grid substation.

Cable Configuration

2b.3.20 The onshore cable system will comprise of four circuits at a voltage between 132kV and 220kV inclusive. Each circuit will comprise of three single-core cables as well as associated communications (fibre optic) cables. The diameter of each cable will typically range from 87mm to 111mm. Each cable will comprise different layers including:

- Conductor;
- Insulation;
- Core screen;
- Metallic sheath for radial water tightness; and
- Oversheath of high density polyethylene.

2b.3.21 The cables are likely to be aluminium and cross linked polyethylene (XLPE) insulated; however they may be copper and/or ethylene propylene rubber (EPR) insulated. An example of a 132kV single core XLPE power cable is shown Figure 2b.3 below.

2b.3.22 The cables will be installed in plastic ducting contained within four parallel trenches with a stabilised backfill and originally excavated material, where suitable. In total there will be twelve cables (three cables in each circuit).

2b.3.23 Concrete cable protection tiles will be fitted above the cables in each trench (two tiles laid side by side per trench), featuring indented lettering warning of the danger of electricity below. Between the protection tiles and the ground surface will be underground plastic warning tape containing a warning text to warn future excavators of the danger of the cable below.

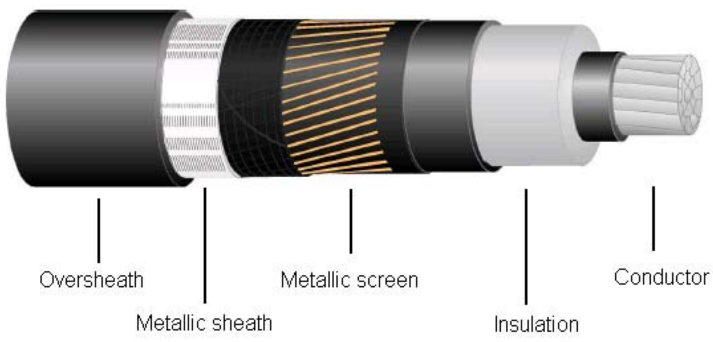


Figure 2b.3: Image of a high voltage single core terrestrial power cable

2b.4 Cable Construction Methodology

Overview

2b.4.1 During the early stages of the Rampion project development following initial stakeholder engagement, the decision was made to underground the entire onshore cable route. This was to eliminate the long term visual impacts associated with overhead transmission lines and towers. The undergrounding of power cables is a well-established technique and environmental management and mitigation measures are incorporated as standard practice.

2b.4.2 In addition, a later decision was made to install the cables in ducting. This reduces the amount of time trenches need to be open, allows quicker backfilling and significantly earlier reinstatement compared to laying cables directly within the trenches.

2b.4.3 Precise construction methods will differ according to the nature of the environment through which the cable route is being constructed. Of particular importance are:

- The underlying soils and strata;
- Existing hydrological regimes;
- The terrain;
- Topography;
- The existence of physical constraints (such as other underground services);
- Infrastructure; and
- Environmental constraints.

2b.4.4 Specific installation approaches will be necessary where the cable route crosses railways, roads and significant watercourses. Refer to Section 2b.5 for further details.

2b.4.5 The 26.4km cable route will be constructed in stages. The trenches will be excavated, the cable ducts will be laid, the trenches backfilled and the reinstatement process commenced. At regular intervals (typically 600m – 1,000m) along the route joint bays/pits will be installed to enable the cable installation and connection process. This approach allows the vast majority of the cable route civil works to be completed in advance of cable delivery and expedite the reinstatement of the disturbed topsoil and subsoil. The trenching and backfilling operations will be split into short sections with each section expected to be completed in a matter of days. Appendix 2b.2 provides an illustration of an indicative trenching sequence.

2b.4.6 Cable delivery will occur as a separate stage followed by cable pulling operations from joint bays. The time delay between the cable trenching/duct laying and the cable installation generally could be between 6 and 12 months. In certain locations, some of the haul road and working width fencing will need to remain in place between the trenching and pulling operations (i.e. would not be reinstated immediately after trenching) as the haul road would be used to access the jointing bays. Such locations will be minimised where possible and these sections of the route will be scheduled for the earliest possible cable delivery and pulling operation. Furthermore, ecologically sensitive areas such as Tottington Mount will be prioritised in seeking to complete the works as quickly as possible.

Working Width

2b.4.7 Construction activities will be undertaken within a temporarily fenced strip of land, known as the working width, which will generally be no wider than 30m, within which will be a 15m permanent easement for the four cable trenches.

2b.4.8 Although the actual working width will generally be no wider than 30m, a general working width of 40m has been defined for the development consent order limits of the cable corridor (the Development Area) to allow 10m for micrositing tolerance. As such, this ES assesses a worst case working width of 40m but it is important to note that the actual working width will be 30m for the majority of the cable route.

2b.4.9 The four individual trenches will be placed at 3m centres within the cable easement. The nominal width of each cable trench (i.e. the width at the base of the trench), will be at least 0.6m but not greater than 1m; however, the trench is likely to have sloped sides and will therefore be wider at the surface than at the base.

2b.4.10 The working width will incorporate storage space for excavated material (a 4m wide subsoil storage area and a 6m wide topsoil storage area) and a haul road (5m wide) for the safe passage of construction personnel and machinery alongside the cable trench. There are some sections where the working width will vary, for example at the HDD compounds and locations of chalk grassland, to store the excavated material in order to mitigate damage (as discussed in Section 24 – Ecology).

2b.4.11 An indicative working width layout is shown in Figure 2b.4 below.

2b.4.12 The working width will be extended in various places to facilitate the construction of the cables across certain road, watercourse and service crossings and where specific installation approaches (e.g. HDD) are proposed, to provide storage for excavated material from drill pits, off-road temporary parking space, access requirements and equipment such as that needed for the construction of crossings and for temporary dewatering.

2b.4.13 All aspects of the construction work will be in accordance with the Construction (Design and Management) Regulations 2007.

Pre-construction Work

2b.4.14 Pre-construction activities will include the following:

- Ecological pre-construction work;
- Archaeological pre-construction work;
- Utilities searches;
- Drainage surveys;
- Thermal resistivity survey to determine surface temperature and soil thermal resistivity in summer and winter;
- Geotechnical and ground stability surveys; and
- Site investigations such as pre-construction contamination surveys.

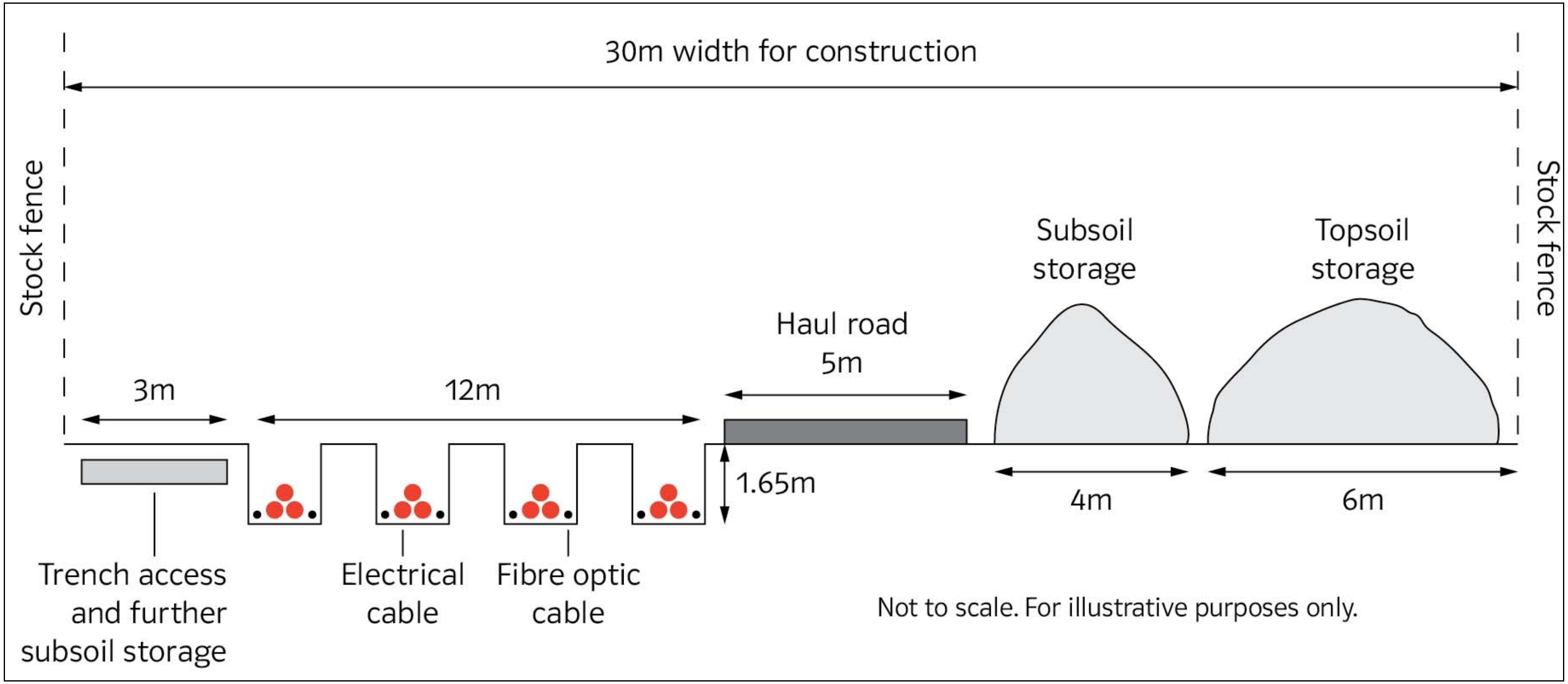


Figure 2b.4: Indicative cable trenching arrangement and working area

Compounds and Access

2b.4.15 At various points along the cable route there will be a requirement to install temporary site compounds which will provide site facilities for the workforce whilst also enabling materials and machinery to be stored safely and securely near the works, so they can be accessed and delivered easily when they are needed.

2b.4.16 There are two types of compound – main compound and satellite compound (also referred to as local compound).

2b.4.17 The main compound will be used during the whole of the construction period (2 years) and used to store larger materials that can then be moved to the satellite compounds when constructing a specific section of the route.

2b.4.18 Satellite compounds are smaller, located at regular intervals along the cable route and would generally be used to store and distribute materials to construct the cable route in a specific section.

2b.4.19 The exact locations of the compounds have not yet been identified, as the principal contractor will have an input into the decision process. However, an indicative broadly even distribution of compounds along the cable route has been assumed for the purposes of this ES. The final locations will be chosen to allow easy access to and from the cable route whilst also minimising impact on local residents, businesses and the environment, wherever possible.

2b.4.20 Where possible, the construction process will seek to utilise unused farm buildings and areas of hard standing which will already have sufficient access for long and/or wide vehicles and negate the need to construct buildings, access roads, etc. Preparatory works for the compounds may involve some clearance work, minor earthworks to level the site, drainage and pavement works for the car park and service installation. Services to the site cabins and offices for the main compound may include electrical, communications, water and sewerage facilities.

2b.4.21 Materials and machinery would be delivered to the compounds, stored for a period of time, and then distributed to the construction sites as required. These deliveries would then be carried out by lorries and tractors which would use designated access routes that will be agreed with the local highways authority to get to and from the compounds. Measures at the entry/exit to compounds, for example wheelwash facilities, will be put in place to ensure roads are kept clean and tidy.

2b.4.22 Materials and machinery that would be stored at the compounds include;

- Cables, ducting, marker tape, cover tiles, etc;
- Plant and machinery;

- Aggregates – although the majority of aggregates will be delivered direct to the construction site; and
- Fuel for machinery.

2b.4.23 In addition staff welfare facilities (e.g. car park, toilets, kitchen, showers, etc.) will be provided and, at the main site compound, local office accommodation. Compounds would be secured to prevent theft of materials and trespassing with advice from the local police. Compounds will have some artificial lighting installed, which will be faced inwards and downwards toward the compound. The main activities at compounds will take place during daylight hours and there may be 24 hour security in place at each operating compound.

2b.4.24 It is anticipated that the compounds would be used Monday to Friday from 7am until approximately 7pm and on Saturdays until approximately 1pm. Use required outside these hours would by exception and be subject to approval of the local authority.

2b.4.25 Following completion of the works, and when it is deemed surplus to requirements, each compound site would be returned to the standard stipulated by the landowner and the relevant local authority.

Main Compound/Site Office

2b.4.26 The installation contractor will need to contribute to the decision on where the main site compound for the route will be situated. However, the northern area of the cable route is much more rural with less congestion than southern areas of the route and it has been identified as being more suitable for the main site compound as it has strong transport links allowing for greater accessibility for plant, personnel and equipment.

2b.4.27 The estimated footprint of the main site compound will be of the order of 150m x 100m. This could potentially be reduced through encouraging contractors, where practicable, to use a 'just in time' delivery approach rather than stock piling materials. This also reduces the risk of theft of materials.

Satellite Compounds

2b.4.28 The onshore cable route can be divided into eight major sections and these will need satellite compounds dependant on location and length of each section. The estimated footprint of a satellite compound will be 50m x 50m. Contractors will be encouraged, where practicable, to use a 'just in time' delivery approach rather than stock piling materials, in attempt to reduce the size of the satellite compounds.

2b.4.29 An area has been identified to the north of Tottington Mount for a satellite compound (see Figure 2b.1). This is to support the specialist equipment that will be needed to undertake the works in that area.

2b.4.30 Each HDD operation will require a working area to be established on either end of the HDD and this creates a physical gap between sections of the cable route that denies scope for plant access along the entire cable route. The HDD entrance and exit sites may be retained and utilised, if required, as satellite compounds for trenching operations which would not take place simultaneously within the same route section.

Access

2b.4.31 A large part of the cable route is situated in areas that commonly have large agricultural plant on the main roads and access to each field along the route will be achieved using the same access routes as the local farming community where possible. These will be agreed in advance with the relevant local authorities and the local landowner.

2b.4.32 The precise locations and alignment of all side accesses along the cable route (to provide access from the adopted highway to the working width) have yet to be confirmed. However, two side accesses (St Paul's Avenue and at the foreshore) have been identified and agreed with Worthing Borough Council for the works at Brooklands Park south of the railway line (see Figure 2b.1). Discussions with other landowners are currently ongoing. The location of any further side accesses not located on existing farm tracks, or tracks that require widening will be subject to agreement with relevant local authorities.

2b.4.33 For the purposes of the ES, it has been assumed that the working width will be accessed directly from existing adjacent roads or farm tracks, and that no widening or vegetation (tree/hedgerow) removal would be required as a result of the side accesses.

Preparation of the Working Width

2b.4.34 Temporary fences will be erected along the boundaries of the working width. Gates and stiles will be incorporated as appropriate (for example, where public rights of way or farm access will be maintained). The working width will then be cleared of vegetation, save for sensitive sections where a different approach will be taken (such as at Tottington Mount). Wherever possible, established trees will be fenced off and worked around.

2b.4.35 The construction of the haul road will vary along the route length depending on the local ground conditions, time of year and whether low loaders and cranes need to travel along it. Much of the cable route is across agricultural land and in summer months there may be cases where there is no requirement to import aggregates as the ground will be stable. In other areas (or during periods of adverse weather) there may be the requirement to import aggregates to create a stable surface for construction traffic movements. Other options such as bog-matting and geotextiles will also be considered by the principal contractor, particularly for sensitive sections of the route, such as Tottington Mount where commitment to use bog-matting or similar surface to reduce impact on chalk grasslands, has already been made.

Topsoil Stripping

2b.4.36 Once the working width has been cleared of vegetation, the topsoil will be stripped. The precise method of stripping and the depth to which the soil will be stripped will be determined during the detailed design. Machinery with low ground pressure will be used to minimise soil compaction where the soil conditions indicate that compaction is possible. The topsoil will be stored to one side of the working width in such a way that it is not mixed with subsoil or traversed by vehicles. Typically, this will be in an earth bund of a maximum height of 2m to avoid compaction from the weight of the soil. Storage time will be kept to the practicable minimum to prevent the soil deteriorating in quality. Topsoil stripped from different fields will be stored separately, as will soil from hedgerow banks or woodland strips.

2b.4.37 Particular care will be taken to ensure that the existing land drainage regime is not compromised as a result of construction. Land drainage systems will be maintained during construction and reinstated on completion. Temporary cut-off drains will be installed parallel to the trench-line, before the start of construction, to intercept soil and groundwater before it reaches the trench. These field drains will discharge to local drainage ditches through silt traps, as appropriate, to minimise sediment release.

Trench Excavation

2b.4.38 Trenching will be the standard installation method for the onshore cable route. Four individual trenches within the permanent easement will be excavated using tracked mechanical excavators (similar to that shown in Figure 2b.12) and uPVC cable ducting will be laid in trefoil arrangement within each of the trenches prior to the installation of the cables.

2b.4.39 A nominal depth of 1.65m to the base of the trench is assumed which is based on experience from similar projects. Deeper trenches may be required at specific crossing locations (such as watercourses). . In areas that cannot be ploughed, e.g. chalk grasslands, the trench will only be approximately 1m deep.

2b.4.40 Each cable trench will have a nominal width of 0.6m but not more than 1m. The trenches may have sloped sides and be wider at the surface to prevent trench collapse. The removal of topsoil will generally be over the working width and stored locally to be evenly spread over the backfilled trenches following duct installation. In particularly sensitive sections of the route, such as chalk grasslands at Tottington Mount, specific techniques will be employed to limit the amount of topsoil removed to the width of the trenches only rather topsoil being removed across the entire working width. In areas with a high water table, it may be necessary to dewater the excavation. Dewatering of the trenches will normally involve pumping the water into settlement tanks prior to discharge to a local watercourse, with the approval of the Environment Agency.

2b.4.41 It is expected that the farmland along the route is generally stable, however the use of a geosynthetic material such as 'Terram' may be necessary in localised areas. Geotextiles can be used to temporarily control and minimise erosion or transport of sediment from unprotected construction sites.

Installation and Backfilling

2b.4.42 Following trench excavation, a thin layer of stabilised backfill (sand based material) will be deposited into the trench to act as bedding for the cable ducts which will then be lowered into the trench. The end of ducts will be temporarily plugged at joint bay locations.

2b.4.43 Each of the trenches will then be backfilled, with the originally excavated material. During backfilling, protective cover tiles (approximately 0.3m wide x 1m long) and warning tapes will be placed over the circuits. The joint bays could be temporarily backfilled (if so the bays will require a second excavation to install the cable once it arrives on site although this is a relatively minor localised activity using a standard excavator).

2b.4.44 Figure 2b.5 presents further information for one of the four trenches and the trefoil cable arrangement proposed. The schematic shows the indicative depth of the three single core cables within ducts, the fibre optic cables also within ducts, the protective cover tile and marker tape.

2b.4.45 Any surplus material from trench excavation may be spread and compacted across the working width before the topsoil is reinstated on a field-by-field basis, provided this will not impede achievement of restoration objectives, the materials are compatible and the landowner is in agreement. The landowner/occupier will also be consulted before any off-site disposal is planned. In such instances disposal will be undertaken in accordance with the Waste Management Regulations.

Cable Joint Bays

2b.4.46 Cable jointing bays (which will be approximately 7m long/2.5m wide/1.5m deep) will be constructed below ground at regular intervals along the cable route to allow cable pulling and jointing at a later stage. The bays will consist of concrete bases to support the cable joints. The precise location of the jointing bays will be determined during detailed design. Wherever possible the joint bays will be located at the edge of field boundaries or roads to facilitate easy access for cable pulling operations. In cases where a hard standing does not exist beside a joint bay one may need to be constructed if the ground conditions do not provide enough stability.

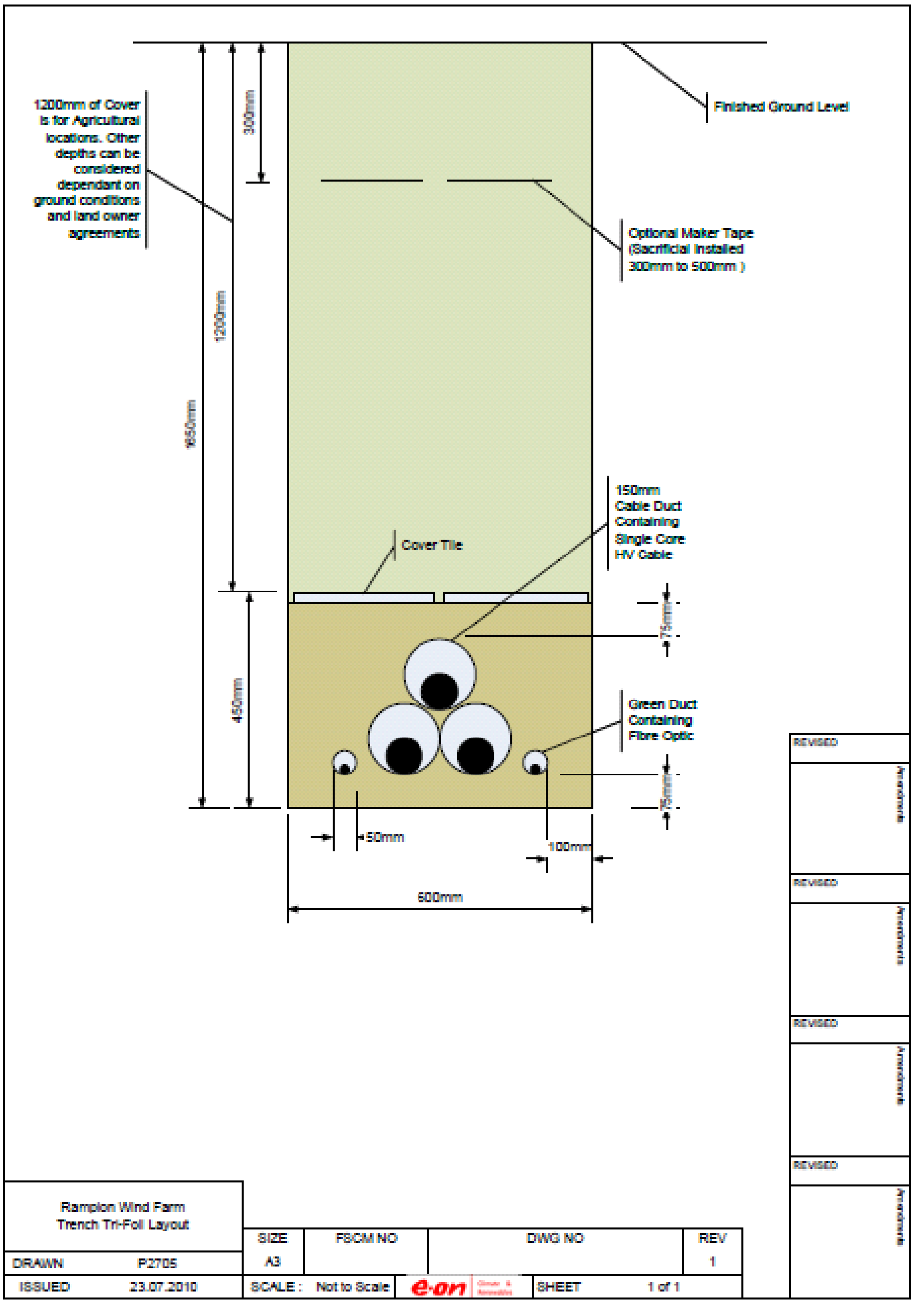


Figure 2b.5: Indicative cable burial depth and detail of trefoil arrangement

Reinstatement

2b.4.47 The ground will be reinstated with the stored topsoil and subsoil following trenching. If necessary, the subsoil will be ripped prior to topsoil placement if compaction has occurred. Topsoil will be spread in such a way as to ensure that it does not become compacted. All surplus construction materials will be removed on completion of the work.

2b.4.48 Following reinstatement of soil and subsoil, final restoration of the cable route will commence. However, at the jointing bays access may need to be retained to facilitate cable pulling, jointing operations and any associated works. Once these operations are completed the additional reinstatement of the bays and their respective access points and areas of hard standing will begin. Restoration activities will include, reseeding of pasture land, reinstatement of field boundaries e.g. permanent fences and suitable hedgerow species replanted. Replacement planting will be carried out during the first appropriate planting season following site restoration. In ecologically sensitive areas special restoration may be necessary.

2b.4.49 The cable route will be marked with marker posts at field boundaries. These will be visible from the ground and all marker posts will be located to minimise interference with agricultural activities.

Cable Delivery

2b.4.50 Cables will be delivered in drums, with the cable lengths on the drums being specified during design and procurement phases (maximum length is likely to be in the order of 1,000m). The indicative maximum drum weights for the maximum deliverable cable lengths can reach up to 27 tonnes. Depending on the diameter of the cable drum, low loader transport vehicles may be required in order to pass under height restrictions such as road or rail bridges.

2b.4.51 Where possible, cable drums will be delivered directly to the construction site from the factory; alternatively they will be stored in either the main compound or one of the satellite compounds until required.

2b.4.52 If the cables are delivered directly to the construction site a hard standing will need to be constructed adjacent to each joint bay to facilitate the offloading and short-term storage of the cable drums. The hard standing will be capable of supporting at least three cable drums and a mobile crane. The hard standing will have a footprint of approximately 10m x 30m it will be located within the working width and be capable of supporting around 150 tonnes.

Cable Pulling

2b.4.53 Cable pulling through the ducts can take place at any time after the ducts have been installed and backfilled, as the ducts are left unfilled after installation. The time delay between the cable trenching/duct laying and the cable pulling could generally be between 6 to 12 months except at sensitive locations where this needs to be completed as soon as practical. Pulling operations will be carried out within the working width. Figure 2b.6 shows an example of HV cable pulling operation.

Figure 2b.6: Example of HV cable pulling operation

Cable Jointing

2b.4.54 Cable jointing will take place inside a temporary jointing shack. During jointing a small generator to provide electric power for the jointers is necessary. A typical cable jointing shack and a cable jointing operation is shown in Figure 2b.7 and Figure 2b.8. On completion of cable jointing, the joint bays will be backfilled to ground surface level with a stabilised material such as cement bound sand (CBS) which assists in holding the cables in position and whose thermal conductivity properties prevent overheating. Excavated material removed to create the bay is used as the top layer.

2b.4.55 Cable tiles and warning tape will be laid above the joint bay to provide a warning in case of inadvertent excavation. In general, the cable jointing bays will be completely buried and will not require manhole covers.

Figure 2b.7: Image of a HV cable jointing shack

Figure 2b.8: Image of a HV cable jointing operation

2b.4.56 At each joint bay, specialist cable sheath bonding equipment will be necessary. Bonding equipment will be housed in secured surface link boxes located within 10m of each joint location. Permanent access will be required to the link boxes during the operation of the Project. The bay that is necessary for these boxes will have a footprint of approximately 1.5m x 1.5m, with an approximate depth of 1m and accessed via a shallow manhole cover for inspection and maintenance. An image of a link box is shown Figure 2b.9.

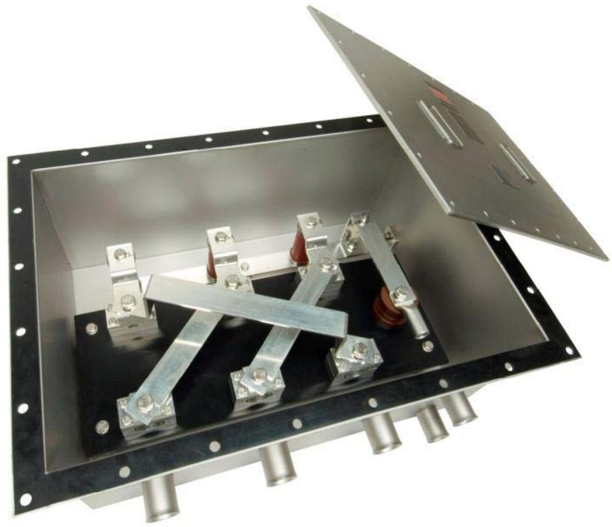


Figure 2b.9: Link box for cross bonding of HV cables

2b.5 Onshore Cable Specific Installation Approaches

Cable Landfall and Transition Pits

2b.5.1 The onshore cables will interface with the offshore cables at the cable landfall. The landfall will consist of four transition pits within which the offshore cables will be connected onto the four onshore circuits. The proposed cable transition pits will lie within Brooklands Pleasure Park near East Worthing; the working area, which will contain the transition pits, is shown in Figure 2b.1. The four offshore cables will be installed underneath the beach and the A259 Brighton Road using horizontal directional drilling (HDD) to bring the subsea cables to the landfall transition pits.

2b.5.2 Each of the four transition pits will be underground, approximately 1-2m below the surface and will have approximate dimensions of 12m x 4m. Once the cables have been installed and jointed, each pit will be backfilled (with a stabilised backfill) and the surface returned to its previous condition on top of protective concrete tiles (laid flat denoting presence of HV cables below).

2b.5.3 The construction of the transition pits at the landfall will likely involve:

- Securing the area around the transition pits with fencing;
- Removal of the topsoil;
- Mechanical excavation of transition pit chamber. Excavation will be slightly larger than the transition pit dimensions. Excavated material may either be used as backfill or removed from the site and suitably disposed of;
- Construction of concrete transition pit chamber walls and base; and
- Temporary backfill (stabilised backfill) of the transition chamber until the cables are installed.

2b.5.4 There will be up to three manholes per transition pit for inspection and maintenance purposes.

2b.5.5 When the cables are ready to be installed, the offshore cables will be pulled into the pit through the ducting and split into their component three-phase cores along with the fibre optics. The onshore underground cables will be similarly pulled into the transition pit through their respective ducts and secured. The two types of cable will then be joined together; the fibre optic cores will also be joined.

Horizontal Directional Drilling

2b.5.6 Where it is not possible to install the cable ducts in open cut trenches, trenchless techniques will be employed. Horizontal directional drilling (HDD) requires the use of specialist equipment to install ducting at challenging crossings without the need for digging a trench along the cable route.

2b.5.7 A typical HDD operation involves drilling a pilot hole from the entry point toward the exit point, reaming (to make the hole larger), pulling a duct through the reamed hole, then pulling the cable through the ducting either at that time or at a later stage. Drilling fluid is jetted through the reamer to lubricate during cutting and to transport cuttings out of the larger diameter hole. This procedure is repeated until the drilled hole has reached the intended final diameter. The hole is typically cut to a size 25% to 50% larger than the duct it has to carry. This is to facilitate the passage of soil cuttings as well as the duct and to allow for soil expansion during pulling.

2b.5.8 A non-saline supply of water will be required for mixing drilling mud and general site usage. Depending on the bore size, bore length and pump capacity, water demand may be 30m^3/hr with a maximum demand of up to 60m^3/hr provided circulation is maintained. Therefore, depending on the type of water source and the distance of the source from the rig site, some preparatory works may be required to produce the initial water volume required for pilot drilling. This may require the construction of a temporary water storage facility on site, or alternatively in some cases water supplies can be brought in by road.

2b.5.9 Large scale HDD (greater than 400m in length) will be employed at the following locations, as depicted below.

- Landfall/A259 (Section 1 on Figure 2b.1);
- Railway line (south of A27) (boundary of Section 1/2 on Figure 2b.1);
- Sompting By-Pass (A27) (boundary of Section 2/3 on Figure 2b.12); and
- River Adur/A283 (boundary of Section 4/5 on Figure 2b.1).

2b.5.10 Small scale directional drilling (less than 50 m in length) may be required at minor road, watercourse or hedge crossings and these will be finalised by the contractor during detailed design phase.

2b.5.11 Two construction site areas with joint bays will be prepared for a typical HDD crossing; firstly the HDD rig site where the HDD enters the ground and secondly the exit point on the other side of the crossing. The exit point is also typically the area where the ducting will be joined together into longer strings to be subsequently pulled through the bored hole back toward the rig site.

2b.5.12 For large scale HDD, a typical working area of approximately 50m x 50m, or variations of these dimensions to achieve a practical 2,500m^2 area, will be required at the HDD rig site to accommodate the drilling rig itself, as well as ancillary equipment, offices, working facilities and storage of bentonite (drilling fluid), water and drill pipes. At the exit side of each crossing an area of approximately 30m x 25m will be required to encompass the exit pit and the mud storage facility. The exit point and ducting stringing areas generally require limited site preparation. Topsoil is usually stripped and areas of poor ground may be treated with imported stone fill.

2b.5.13 Both the entry and exit sites will require temporary access roads and the exit site will require a duct stringing area of approximately 25m wide that is long enough to accommodate the full length of duct being pulled through the hole once reamed. The cable route is usually used as a temporary stringing out area.

2b.5.14 The onshore cable route has four separate circuits, therefore four separate HDD lines will be required at each HDD crossing. The minimum cover required for HDD operations underneath a crossing will be dependent on the results of the site investigations and the detailed design. A typical drill depth under a river is 10m.

Landfall/A59 Brighton Road

2b.5.15 There are two options available for performing HDD at the landfall (with the preferred option to be determined during detailed design:

- Drilling from the north, i.e. drill from onshore to offshore; or
- Drilling from the south, i.e. drill from offshore to onshore.

2b.5.16 Drilling from onshore to offshore is the most likely scenario. The HDD would provide four horizontal directional drills. The diameter of each bore is expected to be no greater than 600mm.

Drilling from the north

2b.5.17 The entry point for the HDD, where the HDD rig would sit, would be located in the pitch and putt golf course at Brooklands Pleasure Park providing adequate space for the rig, equipment and compounds. This park is a former landfill and investigations will be undertaken to assess the extent, stability and level of contamination of the former landfill site and agreement will be sought from Worthing Borough council regarding suitable methodologies and mitigations for this work (see Section 22 -Ground Conditions).

2b.5.18 Offshore, the ducting would be floated on a barge to each drill exit point and the ducts pulled into the bores where they would be sealed until the cable is ready to be installed.

2b.5.19 A suitable working area will be required at the entry point. An area of over 7,000m^2 has been identified (encompassing the landfall and construction area) in Brooklands Pleasure Park to accommodate the drilling rig itself, as well as ancillary equipment including mud tanks, mud cleaning equipment, mud pumps, pipe and materials storage, generators, control room, temporary offices, welfare facilities and workshops. The cables will be drilled beneath the beach. A temporary side access will be located across the foreshore during construction of the landfall. A section of beach (approx 500m) will be temporarily closed during construction of the landfall works, with closures determined by the tides.

Drilling from the south

2b.5.20 With this method, a barge mounted HDD rig would be employed; the entry point would be in the intertidal zone and the exit pit in Brooklands Pleasure Park. The drilling rig would drill four bores towards the park where the ducting would be located.

Railway Crossing

2b.5.21 Site investigations will be undertaken to facilitate the detailed design of the HDD at the railway crossing. Preliminary studies indicate that this HDD will provide a horizontal drill length of approximately 400m-500m depending on the precise entrance and exit locations. The depth of the HDD will be determined during detailed design with approval from Network Rail.

2b.5.22 At the anticipated drill depths it is necessary that the cable circuits are more widely spaced due to thermal effects on the cables at these increased depths. Thus the permanent easement has been increased from 15m to 30m at this location.

2b.5.23 Historical landfills are located to the north and south of the railway crossing. The ducts will be sealed to prevent seepage of contaminated fluids down the duct prior to the installation of the cable.

2b.5.24 It is expected that the HDD operation will be drilled from the south of the railway crossing for greater duct stringing out space, however, drilling from the north may also be considered during the detailed design phase.

2b.5.25 Access to the southern end of the site is via St. Paul's Avenue and into Worthing Borough Council land upon which the HDD entry pit will be located. Access to the northern site can be done via the haul road or alternatively by the creation of a temporary access from a farmer's private track located off Loose Lane, which would require landowner and local authority permission.

A27 (Sompting By-Pass) and Upper Brighton Road

2b.5.26 This extended HDD would provide a horizontal drill length of approximately 250m-500m depending on entrance and exit locations. The HDD will pass underneath Sompting By-Pass; a dual carriageway, and possibly under Upper Brighton Road.

2b.5.27 Access to the south can be achieved using Upper Brighton Road. The use of Bramber Road for the initial site establishment may be possible.

2b.5.28 For both ends of the HDD operation access could also be gained using the cable route spread and haul road but this would require further distance for plant to travel.

River Adur Crossing

2b.5.29 The River Adur HDD would provide a horizontal drill length of approximately 400m-500m depending on the precise entrance and exit locations. It will cross beneath the river, a cycle track, a dismantled railway line and Steyning Road (A283).

2b.5.30 The HDD bores shall be deep enough so that the river bed is undisturbed and the drilling fluid even under pressure does not leak into the river.

2b.5.31 The crossing has been located at this point as it presents a relatively short drilling route. On the eastern side of the crossing are two chalk embankments, between which the cable route will lie. These embankments will not be excavated as they are ecologically sensitive (Old Erringham Valley and Road Cutting SNCI).

2b.5.32 Two options for performing the HDD at this crossing are to drill either from the north or from the south. There are advantages and disadvantages to both options and these will be investigated during detailed design, including space availability and appropriate site access.

Specific Crossing Approaches

Minor Road Crossings

2b.5.33 It is expected that this type of crossing will be trenched and backfilled. Minor road crossing types relate to a narrow width road such as a country lane in which the road will not accommodate two vehicles side by side; vehicles can only pass at passing bays.

2b.5.34 To keep access open along the road while construction of the trenches takes place, the road may need to be temporarily widened to a width that would easily accommodate two-way traffic of vehicles. This will allow half of this width to be closed off to traffic while the road is trenched to half way across and cables/ducts installed. The second half of the road will use traffic management signals to keep access open to road users. The level of excavation required will be determined by standard road crossing profiles and any other services running parallel with the road at detailed design stage. The road will be reinstated following backfilling of the trenches.

2b.5.35 Minor road crossings will be trenched and shall conform to the New Road and Street Works Act 1991, Part III.

Standard Road Crossings

2b.5.36 This crossing type relates to a road suitable for two way traffic such as Horn Lane. It follows the same method as described above for Minor Road Crossings except that generally the road will not need to be temporarily widened prior to beginning excavation. This will be determined following a detailed survey of the road at the crossing point and whether there is currently enough room to close one lane and carry out the excavations.

2b.5.37 Standard road crossings will be trenched and shall conform to the New Road and Street Works Act 1991, Part III.

Drain Crossings

2b.5.38 Where possible, drains will be temporarily diverted and then reinstated to allow trenching of the route to continue. If this is not possible (to be determined at the detailed design stage), mini-HDD, pipe jacking or a similar process will be used to install ducts.

2b.5.39 Pipe jacking usually involves hydraulic jacks pushing specially designed pipes/concrete sleeves through the ground behind a shield at the same time as excavation is taking place within the shield. The excavated material is removed via the exposed end of the sleeve. Once the sleeve is installed, ducts are inserted into the sleeve.

Stream Crossings

2b.5.40 Stream crossings can be identified along the route as those that permanently contain flowing waters throughout the year and as such they differ from drainage ditches around farmland. The EA will be consulted to determine the most appropriate method for each crossing and the appropriate method statements will be prepared.

2b.5.41 A number of factors will affect the choice of crossing method including: depth of water; available space; duration of works; bed conditions; accessibility; and potential ingress of water. Apart from the River Adur crossing identified for HDD, the default crossing method of watercourses will be trenching, but mini-HDD may also be employed in certain cases.

2b.5.42 The cable route haul road will traverse across the stream using a temporary bridge, which will lie within the working width.

2b.5.43 The exact methodology to achieve an open trench across each stream and the temporary bridge arrangements required will be decided by the works contractor in consultation with and the approval of the EA. The profile of the trench running through the stream is determined by the required cover underneath the stream bed, surrounding stream bank profiles and minimum bend radii of the ducting trefoil.

2b.5.44 Open cut crossings can either be wet or dry. One dry technique involves damming the watercourse upstream and downstream of the crossing, thus creating a dry area where the cable will cross. Water is then pumped from where it has been impounded upstream and discharged downstream of the crossing area.

2b.5.45 In the wet open cut technique, construction takes place within flowing water. The cable trench is typically constructed across the watercourse by equipment operating from either the banks or from flume pipes laid in the river to maintain flow and provide an equipment crossover from one bank to the other. After excavation of the trench, ducting will be placed into the trench.

2b.5.46 Timing of the works is important; periods of low flow will be chosen wherever practicable. This will result in a quicker deposition from the water column of any sediment released.

2b.5.47 The working width will be reduced to 20m at specific watercourse crossings as listed in Table 2b.1.

Reduced Width Hedgerow Crossings

2b.5.48 Several hedge crossings along the cable route have been identified as sensitive to native bats in the area that use the hedge line for orientation and guidance at night. As such, when crossing these hedges it will be important to keep the section of hedgerow removed to a minimum. Soil storage will be temporarily stored either side of the hedgerow which reduces the working width to 20m and therefore reduces the amount of hedgerow removed at the crossing point. Specific hedgerow crossings are listed in Table 2b.1.

Table 2b.1: **Reduced Working Width Sensitive Ecological Crossing Locations (see Figure 2b.1 for location of relevant crossings)**

Crossing No.	Crossing Type	Sensitivity	Description	Proposed Mitigation
01-01	Landfall	Ecology	Environmental impact on foreshore due to traversing of heavy vehicles during construction	Matting will be laid on foreshore during cable landfall operation
02-17	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location. Possibility that it may be crossed by HDD as part of Sompting- Bypass HDD.
03-02	Hedgerow	Invertebrates	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
03-06 to 03-07	Hedgerow	Dormouse	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
04-01	Hedgerow	Dormouse	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
07-02	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
07-05 to 07-08	Other	SNCI	Impact to ASNW and SNCI to be avoided, pinch point east of River Adur	HDD used to minimize impact on SNCI and reduced working width used to minimise impact on ASNW.
07-11	Other	Mature Tree	Group of mature trees to north of easement	Working area will be sided to south of easement. Mature trees will be fenced off during construction
South of 11-01	Hedgerow	Bats	Sensitive hedgerow for bat foraging runs parallel to western edge of easement.	Working width will be maintained to the east.
11-05	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
11-08	Ditch	Mature Tree	Mature tree to be avoided	Cable easement will be micro-sited to avoid impacting on mature tree. Tree will be fenced off during construction
12-01	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
12-03	Hedgerow	Mature Tree	Mature tree conflicting	Route will be micro-sited to

Crossing No.	Crossing Type	Sensitivity	Description	Proposed Mitigation
			with easement	the east where possible to avoid impacting on tree
12-03	Stream	Ecology	Sensitive stream crossing, risk to stream ecology	Working width to be reduced to 20m at this location.
12-05 & 12-06	Stream	Ecology	Sensitive stream crossing, risk to stream ecology	Working width to be reduced to 20m at this location.
12-09	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location and easement micro-sited to the east.
12-10	Hedgerow	Mature Tree	Mature tree conflicting with easement	Easement will be micro-sited where possible to avoid impacting on mature tree.
14-04	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
14-04 to 14-06	Other	Other	Marshy grassland to west of easement	Working area will be sided to east of easement to avoid marshland.
15-01 to 15-04	Hedgerow	Ecology	Hedgerow running parallel to west of easement between these crossings.	Working area will be sided to east of easement to avoid removing long length of hedgerow.
15-02	Other	Mature Tree	Impact on mature tree standing within working area	Working area will be sided to west of easement. Mature tree will be fenced off during construction.
15-07	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location.
15-09	Ditch	ASNW	Woodhouse Wood ASNW impinges onto the west working area.	Working width to be minimised to avoid impact on ASNW. Working area will be sided to east of easement.
16-02	Stream	Ecology	Sensitive stream crossing, risk to stream ecology	Working width to be reduced to 20m at this location.
16-06	Hedgerow	Mature Tree	Two mature trees located at this crossing, one on either side of cable easement.	Working width to be minimised to avoid impact on these mature trees.
16-06 to 16-11	Hedgerow	Ecology	Hedgerow running parallel to east of easement between these crossings.	Working area will be sided to west of easement to avoid removing long length of hedgerow.
16-11	Hedgerow	Mature Tree	Multiple mature trees at this crossing. Treeline to be maintained where possible	Likely that at least some of tree line will be impacted during construction (~12m width). Working width to be reduced to 20m at this location.
16-13	Hedgerow	Bats	Hedgerow breach to be minimised	Working width to be reduced to 20m at this location and micro-site further north.
16-14	Road	Mature Tree	Mature trees are situated on both sides of the road. There is also a pond on	Working width to be reduced to 20m at this location.

Crossing No.	Crossing Type	Sensitivity	Description	Proposed Mitigation
			the south side of the road.	
17-02	Other	ASNW and Bats	Paddock Wood ASNW to the west of easement here. Sensitive area for bat foraging also.	Working width to be reduced to 20m at this location.
17-05	Track	Bats	Hedgerow breach to be minimised	This access track will be crossed by mini-HDD, hedgerow will not be breached.
17-06	Hedgerow	Barn Owl	Mature tree to be avoided, home to a barn owl	Cable easement will be micro-sited east to avoid impacting on mature tree. Tree will be fenced off during construction .
18-06	Stream	Ecology	Sensitive stream crossing.	Working width to be reduced to 20m at this location.
18-02	Stream	Ecology	Sensitive stream crossing.	Working width to be reduced to 20m at this location.
South of 19-51	Hedgerow	Ecology	Hedgerow running parallel to west of easement between these crossings.	Working area will be sided to east of easement to avoid removing long length of hedgerow.
19-51	Hedgerow	Mature Tree	Impact on mature tree standing within working area	Working area will be sided to west of easement. Mature tree will be fenced off during construction

Utilities Crossings

2b.5.49 A utilities survey has identified power, telecommunication, gas, water and sewerage services crossing the cable route at numerous locations. When crossing beneath overhead services care will be taken to safely identify the height of the cables and provide height restriction warning signs and 'goalposts' to safeguard access lines. Safe working methods in accordance with standard industry practice will be employed at all times.

2b.5.50 When crossing underground services it is likely that the cable trenches will be hand dug in places to safely pass underneath existing services, unless the service is extremely deep; this will be determined through further surveys.

Crossing of Scheduled Monument at Tottington Mount

2b.5.51 The cable route will traverse Tottington Mount, which is an elevated ridge of chalk land (grid reference TQ21698, 11098) (see Figure 2b.10). This area is complicated by the geology (chalk) and ecology (chalk grassland) and also by the presence of a Scheduled Monument (SM).

2b.5.52 The SM is a cross dyke once used as a boundary between east and west territories and is below ground. The feature begins and ends on the chalk ridge and runs in a north-south direction, perpendicular to the route of the cable. Further detail is included in Section 25 (Archaeology and Cultural Heritage).

2b.5.53 It is proposed that this section of the cable route will be trenched due to access difficulties for large-scale drilling equipment. Following discussions and agreement with English Heritage, special provisions will be made for the crossing of the SM where archaeologists will in advance undertake excavation and photography of an area 15m x 15m across the dyke at the monument's southern end.

2b.5.54 Works will involve deturfing by hand to expose natural chalk/archaeological horizon. Archaeological excavation will ideally be undertaken once the construction phase has started (i.e. to avoid reinstatement before cable installation).

2b.5.55 Trenching at the SM will be undertaken following the methodology specified for Tottington Mount Section TM2 detailed below.

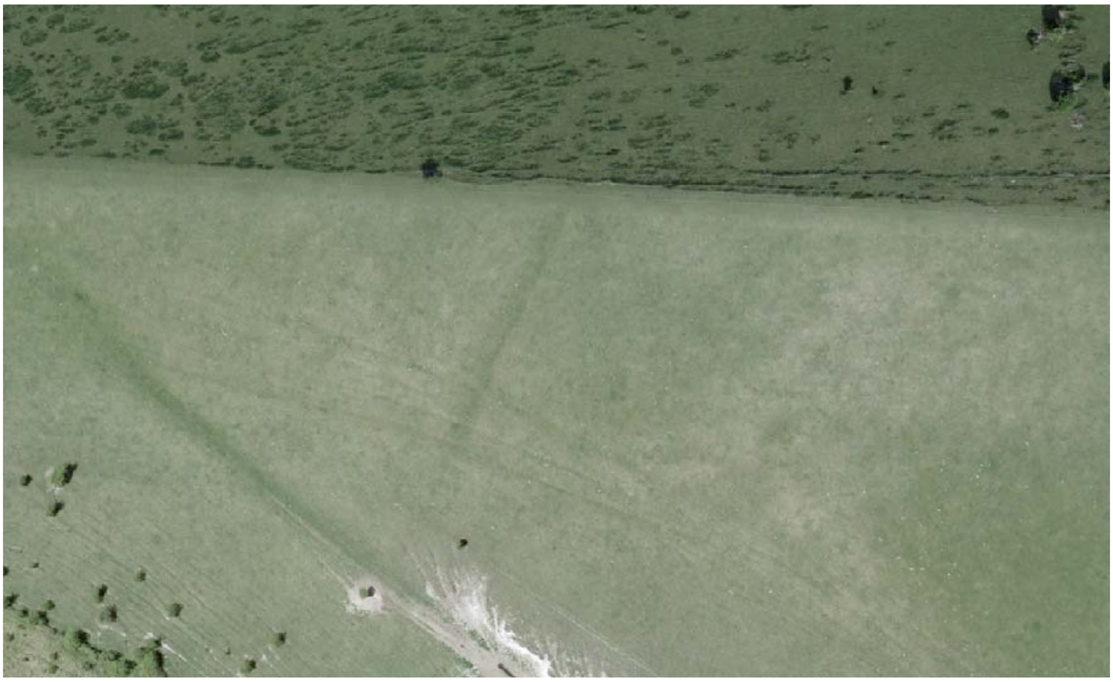


Figure 2b.10: Aerial View of Tottington Mount Scheduled Monument

Crossing of Chalk Grassland

2b.5.56 The proposed cable route crosses chalk grassland in two locations: east of Lambleys Barn, and Tottington Mount. Both of these areas are on steep slopes. A review of existing studies shows that a number of reinstatement techniques have been considered for chalk grassland including turf lifting within the cable easement, and protection of specific areas followed by natural colonisation and potentially re-seeding in the remaining work areas.

2b.5.57 The chalk grassland to the east of Lambleys Barn is generally in unfavourable condition and covers a relatively small area (approximately 7,600m^2), therefore the standard topsoil strip and trenching operation will be implemented at this location.

2b.5.58 At Tottington Mount a different construction methodology will be implemented to reduce environmental impacts. The proposed cable route at Tottington Mount has been divided into three sections (see Figure 2b.11) with differing topography and therefore involving different engineering approaches:

- Section TM1 (approximately 800m in length) traverses a hillside with slopes of up to 1:5. This section is not designated as chalk grassland but exhibits some similar qualities and due to the side slope in this section requires a specific approach to be taken;
- Section TM2 (approximately 800m in length) follows the contours down the hill with slopes of up to 1:4, over a Scheduled Monument (see above) and chalk grassland; and
- Section TM3 is over the last 100m of very steep terrain with possible gradients of 1:2.5. Part of this section crosses chalk grassland.

2b.5.59 Further details on the methodology for each of the sections at Tottington Mount are detailed below. Appendix 2b.1 provides indicative drawings for each section.

Section TM1

2b.5.60 The haul road will require a small degree of temporary benching in this section to ensure a level surface for plant to traverse at all times. The topsoil and subsoil from the haul road will be deposited to the higher side of the working width, away from the trenches. This will enable the reinstated area above the ducts to be completed and seeded whilst maintaining the haul road for access to the two following sections along Tottington Mount until all the cables have been installed.

2b.5.61 Topsoil removal for the trenches will take place in two stages, with the two trenches furthest from the haul road being worked first. A 5m width of topsoil will be removed above these first two trenches and stored to the lower side while each trench is individually excavated.

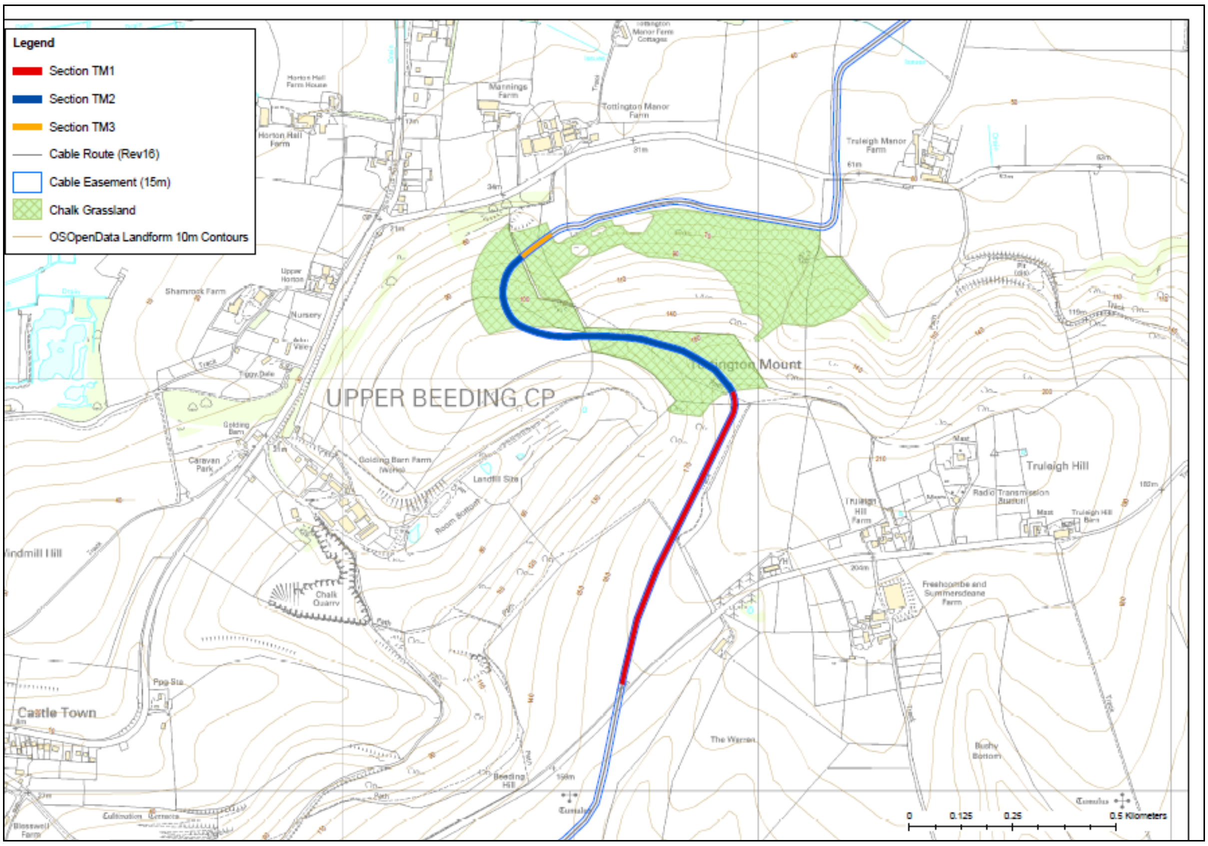


Figure 2b.11: Tottington Mount Engineering Sections

2b.5.62 The first trench will then be excavated with the subsoil stored to one side. The stabilised bedding would then be deposited, the ducting installed and the subsoil replaced over the ducts including the protective tiles and marker tape. The backfilled trench will be re-instated to its original slope profile.

2b.5.63 The second trench will then be excavated with the subsoil being placed over the top of the first trench and the ducts installed and backfilled. The topsoil removed to excavate the two trenches would then be replaced.

2b.5.64 Removal of topsoil for the next two trenches would then begin and this would be temporarily placed above the reinstated first two trenches. Excavation of the remaining two trenches would be undertaken and the process completed as for the first two trenches.

Section TM2

2b.5.65 This section is designated as chalk grassland. The construction methodology in this section will include the use of bog matting, metal trackway or other similar temporary surface for the haul road and storage of removed subsoil, and the removal and replacement (to the original position) of grass turfs above the trenches (ie 4 x 1m).

2b.5.66 A site investigation will be undertaken to establish the properties of the chalk and the depth of topsoil prior to the works. This will assist in determining the details necessary for the handling and the replacing of the turfs and the chalk backfill so that the optimum results can be obtained.

2b.5.67 The turf removal at this section will be reduced to the practical minimum – approximately a 1m wide strip of chalk grassland above each trench will be removed. Between trenches and across other areas of the working width in this section the topsoil will not be removed and the grassland will remain in situ. The estimated footprint of chalk grassland affected by the works in this section will be limited to 3,200m^2.

2b.5.68 The working width has been reduced to 21m for this sensitive section of the route. It will be fenced off and matting will be laid on one side of the working width to create a haul road for plant to traverse up and down the Mount.

2b.5.69 Turves will be removed in defined sections and reinstated back on the ground in the original position after the work is complete. Each turf section will be up to 1.0m x 1.2m in area, cut in depths of up to 300mm, and laid to the side of the working area in single layers. The turves will be stored on a porous geotextile membrane as close as possible to the trench.

2b.5.70 The turves will be laid out individually in the order that they were removed and careful labelling will ensure correct replacement order and position of turfs post-construction. Storage time will be kept to a minimum to prevent the soil deteriorating in quality.

2b.5.71 The equipment to be used for the removal of turf is likely to comprise a specialist head attached to the booms of standard excavators, as shown in Figure 2b.12.

2b.5.72 The trench furthest from the haul will be excavated in practical lengths such that a single section of trench is excavated, ducted and backfilled before excavation of the adjacent trench begins. A light excavator or backhoe will be used for the excavation and it will traverse on matting to minimise the impact on the turf.

2b.5.73 Trench depth will be in the order of 1.2m, shallower than that proposed on agricultural land as Tottington Mount will not be ploughed. The subsoil will be deposited to one side of the trench on the furthest side from the haul road. It will be placed on a suitable membrane to minimise its impact on the surface vegetation.

2b.5.74 The sand based bedding will then be laid in the trench using mini plant, the ducts laid and then backfilled using the original material and the turf replaced.

Figure 2b.12 Specialist Turf Cutting head (Alaska Environmental Contracting Ltd)

Figure 2b.13: Batemag Machine with Cutting Head (Alaska Environmental Contracting Ltd)

2b.5.75 Operations will then move to the beginning of the next trench with the excavated material placed on geotextile membrane over the backfilled first trench. This will be repeated for the third and fourth trenches.

2b.5.76 The turves will be re-laid as near as possible to their original positions and where practicable having the same orientation as before lifting so that the originally adjacent edges of different turves are laid back together. These precautions will maintain the fine scale pattern of the grassland, which has evolved in response to fine-scale environmental variation, and will thus reduce the effects of the disturbance. Gaps between turfs will be minimised by laying the turves as close together as possible and filled with the excess soil left on the geotextile.

2b.5.77 For any areas where turves cannot be recovered or any bare areas remaining after reinstatement these will re-vegetate naturally from a seed bank or by vegetative spread of surviving perennial plants

2b.5.78 If turf removal is unsuccessful then the trenches will be excavated in a single operation and re-seeding will be the primary reinstatement strategy. This will be determined prior to construction activities to enable the creation of a seed bank.

2b.5.79 The chalk grasslands will be monitored regularly for a period of 5 years post construction to ensure reinstatement has been successful. If there are any areas where chalk grasslands have not reinstated fully, remedial works such as further reseeding will be undertaken.

Section TM3

2b.5.80 Section TM3 is over the last 100m of very steep terrain with possible gradients of 1:2.5. Part of this section crosses chalk grassland.

2b.5.81 Two methods (Method A and B) are proposed for this section, the first where the turf is stripped in one operation, and the second where the turf removal and ducting installation are carried out in two stages. The haul road would be discontinued for this section due to the steep slopes and thus this section would be accessed from the northern and southern ends.

2b.5.82 It is noted that due to the steep slope on this section, turf removal may not be deemed practical by the works contractor and in the interests of health and safety excavation of the trenches without turf/topsoil removal may be required. To cater for this contingency, seeds from a local source will be collected and stored prior to the works commencing.

2b.5.83 Due to the steep incline at Section TM3 specialist equipment will be required, as shown in Figure 2b.13.

Method A

2b.5.84 For this method it is proposed that a short 12m wide section at this incline is stripped from the base upwards and the turf stored on the flat area on the level ground at the base of the slope.

2b.5.85 Trenching for the ducts would be performed one at a time with the excavated subsoil placed to the side. The selected backfill would be transported by track machinery and the ducting either assembled above and pulled into place or manually placed.

2b.5.86 The replacement of the turf would be in the reverse order with the top installed first to avoid machinery crossing laid sections.

Method B

2b.5.87 This method would be performed in two stages with the first stage stripping a width of turf approximately 6m wide and placing half to each side. This could be achieved without sidewards movement of the machinery as there is sufficient reach of the boom to reach the storage area. This would give sufficient space to construct the ducting for two trenches.

2b.5.88 Excavated material of the first trench would be placed over the line of the second trench. However access for materials required in the trench is more restricted by this method and the selected backfill would either have to be winched down over the trench in a small hopper and placed manually or laid using the tracked excavator which would pick material up from the base of the slope. The ducting could be assembled in a single trefoil length and pulled into place from above.

2b.5.89 Once the first stage has been completed the second stage for trenches 3 and 4 would commence. It should be noted that although this is an exact repeat of stage 1, half of the stripped turf would be laid on top of the re-laid turf from stage 1. There is a potential for damage to the re-laid turf and this might necessitate additional restraints/anchorages to the re-laid sections.

2b.5.90 If turf removal is unsuccessful then the trenches will be excavated in a single operation and re-seeding will be the primary reinstatement strategy. This will be determined prior to construction activities to enable the creation of a seed bank.

2b.5.91 The chalk grasslands will be monitored regularly for a period of 5 years post construction to ensure reinstatement has been successful. If there are any areas where chalk grasslands have not reinstated fully, remedial works such as further reseeding will be undertaken.

Key Principles

2b.5.92 The following key principles will be adopted for work at Tottington Mount:

- The trenching, backfilling and reinstatement operations will be kept to a minimum to reduce the length of time the stored turf/topsoil is stored.

- The installation of the power cables in the ducts will be sequenced to follow on immediately after the ducts are installed to allow closure of the haul road and the final replacement of the turf as soon as possible.

- The work will be programmed at the optimum time for minimum rainfall as compaction and chalk handling should not be carried out during periods of rain.

2b.5.93 It is expected that the works will be completed within a matter of weeks to optimise reinstatement results.

2b.5.94 Measures will be taken to ensure that drainage of the temporary works will not cause erosion or other detrimental effects on the site. The design of the replacement backfill will incorporate measures to ensure that the excavated trenches do not become natural watercourses and it is expected that impervious barriers will be placed at regular intervals (4-6m) along the trench above the ducts. The frequency of these barriers will be determined by the gradient of the terrain. It is also expected that the selected backfill will incorporate a quantity of cement which, once hardened, will prevent future erosion, especially as the duct surfaces will form a natural water line.

2b.5.95 The handling and particularly the backfilling of the chalk will be carefully monitored to ensure that the replaced chalk is compacted correctly to avoid significant settlement. Backfill of the excavated chalk should not be too finely graded as this might become slurry like. However, there is also the potential of settlement if there are too many voids in the backfill). It is for these reasons that only the minimum quantity of topsoil and subsoil is disturbed during the works.

2b.6 Cable Construction Programme and Delivery

Programme

2b.6.1 The overall construction period for the Project from the commencement of onshore works to completion of commissioning of the wind farm will be approximately 4 years.

2b.6.2 It is anticipated that the onshore cable construction works (excluding the landfall and substation) will be completed within 28 months. The indicative programme for the onshore elements shows continuous working.

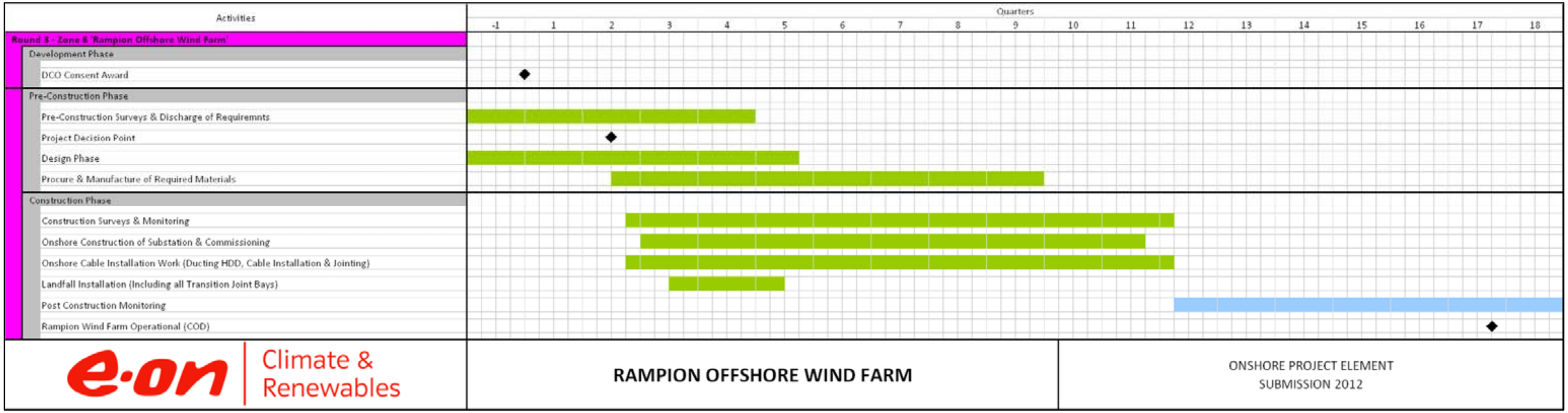


Figure 2b.14: Indicative Programme – Onshore Elements

2b.6.3 The indicative programme assumes that only one cable pulling operation will be undertaken at any one time, however multiple cable pulling teams may be deployed. Trenching operations can take place simultaneously along the route, resources permitting; however, trenching operations leading to a HDD pit will not be performed until the HDD has been completed and the duct entrance/exit point is confirmed.

2b.6.4 Overall installation times for the onshore cable route vary with each section length but typical times for a 1km section of two double circuits, i.e. four groups of three cables are presented in Table 2b.2.

Table 2b.2: Indicative Onshore Cable Construction

Operation	Duration (Weeks)
Trench Excavation, Duct installation and backfilling (per km)	2-3
Reinstatement of cable easement (per km)	4 with an overlap with trenching operations
Cable Pulling (per km)	1-2
Cable Jointing & Bonding Connections (per bay)	3-4
Backfill & Reinstatement (per km)	4 with an overlap with Jointing
Final reinstatement e.g jointing bays	1-3 bays per week

2b.6.5 The use of a ducted cable technique allows quicker reinstatement of the cable route, with the installation of the cable itself able to take place as a subsequent activity by pulling cable via the jointing pits. Subsequent cable installation is estimated to take approximately 80 days. Indicative cable trenching and HDD durations are listed in Table 2b.3. The sequence of works implied in the table does not represent the final construction sequence, which will not be known until all consent conditions are understood. Clearly there will be overlap between some of the activities in order to achieve the estimated 28 month overall duration of works for the onshore cable route.

Table 2b.3: Indicative Cable Trenching and HDD Durations

Operation	Duration (Weeks)
Main Site Compound	3 - 6
HDD Landfall to onshore transition bay	4 - 8
Trenching Section 1	6 - 11
HDD- Railway	6 - 9.5
Trenching Section 2	10 - 15
HDD- Sompting Bypass	6 - 11.5
Trenching Section 3	6 - 11
Trenching Section 4	25 - 47
HDD- River Adur/A283	7 - 13.5
Trenching Section 5	20 - 35
Trenching Section 6	15 - 40
HDD- A281 (optional)	4 - 7.5

Operation	Duration (Weeks)
Trenching Section 7	15 - 32
HDD- B2116 (optional)	5 - 9.5
Trenching Section 8	20 - 37

2b.6.6 Work on the trenching and duct installation will be restricted to 7am to 7pm Monday to Friday and 7am to 1pm on Saturdays. It is however possible that 24 hour working involving lighting will be used for the relatively small number of HDD operations as they need to be completed in one operation, subject to discussions with the relevant local authority

Construction Traffic

2b.6.7 Once plant has arrived on site and begun excavation operations it will not leave site until that trenching section has been completed; however, site traffic along the haulage road will still arise as the plant will require refuelling and maintenance as it works along the cable route.

2b.6.8 Provision shall be provided along the haul road for passing places unless traffic along the cable route uses a one-way system. These passing places will be within the 30m working width. A summary of likely delivery loads is presented in Table 2b.4.

Table 2b.4: Estimate of Material Deliveries for Onshore Cable Route Construction

Material	Quantity	Quantity Per Load	Total Delivery Loads
uPVC Ducting	360km	2.8km	130
Temporary Haul Road (aggregates)	14,500m^3	18m^3	858
Stabilised Bedding	10,440m^3	18m^3	589
HDPE Ducting (for HDD)	8km	600m	16
Bentonite Slurry	400m^3	20m^3	40
HDD Drill Pipes	90 tonnes (2 per HDD)	20 tonne	12
XLPE Cable	360km	1km	361
Cable Tiles	232km	3,000m	77
Miscellaneous	-	-	41
Total Deliveries			**2,124**

Workforce

2b.6.9 The workforce numbers required for the cable route will vary greatly depending on factors such as the agreed construction programme and specific requirements of the chosen contractor. The following numbers would typically be required as a 'permanent' site presence for each trenching operation:

- Trench operations including haul road construction: 15 people;

- Jointing: 5 people; and
- Site management: 3 people.

2b.6.10 Multiple trenching operations would require a similar number of personnel working at each site. Specialists may also be required, such as archaeologists or ecologists. Additional manpower will be necessary during certain activities, in particular cable delivery and cable pulling. This will require up to an additional 20 people for 2 to 3 days at a time. Specialist activities such as mini-HDD of crossings and final testing will require an occasional site presence of typically 5 to 8 people. Large scale HDD will require 8 to10 personnel on site.

2b.7 Onshore Substation

2b.7.1 The proposed onshore substation is a key component of the Project and will be required to convert electricity generated at the wind farm to a higher voltage suitable for onward transmission by National Grid's electricity transmission system. The proposed onshore substation will be located to the east of the 400kV National Grid substation at Bolney. The substation will step up the voltage of the offshore wind farm transmission system (which may be 132kV, 150kV or 220kV) up to the National Grid transmission voltage of 400kV for connection into Bolney substation. The substation would connect into the National Grid Bolney substation by four underground 400kV cable circuits running between the two substations. This will be located within the Development Area shown in Figure 2b.1.

Substation Location

2b.7.2 The proposed substation is located approximately 60m east of the existing National Grid Bolney substation. The proposed location is within land currently used for agriculture and covers an area of approximately 23.3 hectares. The permanent substation compound will occupy an area of land within this. Land has also been identified for construction and laydown which will be required during the 2 year construction programme. Mitigation land has also been identified which will be used for landscaping and visual impact mitigation purposes over the operational lifetime of the substation.

2b.7.3 The proposed site is enclosed along much of its southern boundary by mature deciduous hedgerows and hedgerow trees. Twineham Court Farm is located approximately 50m to the south. Bob Lane and Twineham Grange Cottages are located over 240m to the south.

2b.7.4 The indicative substation layout (excluding landscaping) is shown in Figure 2b.15. Land in the northeast will be used for site establishment and equipment laydown.

2b.7.5 Ground levels vary from approximately +30m Above Ordnance Datum (AOD) at the western end to +18m AOD at the north-eastern tip. This deviation in elevation may require a significant amount of earthworks to provide a flat substation site.

2b.7.6 An existing tree and shrub line running north to south (approximately 200m) and east to west (approximately 350m) are within the permanent substation site and will require clearing ahead of the works. A tree in the centre of field will also need to be removed. A drainage ditch and farm track running parallel to the north to south tree line will also require diversion in part. One public right of way (PRoW) will need to be permanently diverted from its original route as it currently crosses the proposed substation site.

2b.7.7 The site is constrained by the presence of existing high voltage overhead lines and buried cables adjacent to the proposed site. An 11kV overhead line that runs through the site north to south will require diversion by the local distribution operator.

Substation Components

2b.7.8 The key components of the proposed substation are presented in Table 2b.5. The majority of the substation equipment and buildings are not expected to be taller than 10m (and in most cases much lower) however, some of the equipment may extend up to 12.5m at its highest points.

Table 2b.5: Major Substation Components

Item	Indicative Concept Design	Quantity	Approximate dimensions
Super Grid Transformer (complete with air insulated HV and LV Bushings)	Each bay will have a minimum capacity of 180MVA. As a worst case design has assumed that each bay will have a 240MVA rated transformer	4 Bays	Each unit 6m x 16m (including the cooler banks) x 12.5m high (to the top of the bushings) Generally 'Admiral Grey' Bund 14m x 22m footprint
Fire walls (if deemed necessary)	Between oil containing equipment. Made from precast concrete	-	No greater than 22m long x 9m high
Reactive Compensation Equipment	Approximately 30MVAr connected to the LV winding of the SGT would utilise HV air insulated bushings	4	Each unit 4m x 7.5m x 7.1m high, including radiators Bund 12.1m x 8.8m footprint
HV Equipment	Based on air insulated equipment and busbars	-	Typical phase spacing: 5m for 400kV 2.5m for 132kV
MV Equipment	Approximately 15MVAr Reactors utilising air insulated bushings	8	Each unit 4m x 3.5m Bund 8m x 8.8m footprint

Item	Indicative Concept Design	Quantity	Approximate dimensions
	Approximately 15MVAr Capacitor (air insulated)	4	Each unit 5.5m x 6.5m x 7m high
	Auxiliary Transformer	4	Transformer 3.5m x 2.5m x 6m high Bund walls 7.4m x 6.2m
STATCOM unit	Approximately 17.5MVAr	4	14m x 5m
Harmonic Filtering Compound	Harmonic filtering requirements to be determined during detailed design	4	Filter compound complete with equipment connected to the SGT LV Winding 22.5m x 20m x 8m high (nominal height of the filters).
Switchroom	Housing the switchboard to each SGT tertiary winding	4	11m x 5m
Fire fighting water tank	120,000 litre	1	
E.ON control building	Up to 2 storey, including mess room and maintenance staff facilities	1	Footprint 500m^2 to 600m^2
Offshore Transmission Operator (OFTO) control building	1 storey, including mess room and maintenance staff facilities	2	Footprint 500m^2 to 600m^2
Cable connection to Bolney substation	Underground cable circuits	4	n/a

Substation Access

2b.7.9 The route from the A23 to the site area will be via the A272 and Wineham Lane. A temporary construction access (maximum 16m width including spoil storage areas) will be created from a new bellmouth junction from Wineham Lane into private land situated directly north of the National Grid land boundary. The access will traverse east toward the new substation site and will be in place for the duration of the construction works (approx. 2 year period). Figure 2b.2 shows the proposed corridor for the temporary construction access. This corridor will contain a bellmouth (expected to be approximately 30m in width) with Wineham Lane and a temporary access track. The width of the bellmouth at Wineham Lane leading to the access track will be confirmed during discussions with the relevant local authority and the landowner. The bellmouth will be wide enough to allow access and egress to and from the substation site. The exact routing of the construction access is still being determined and will require detailed design. Gaps between trees will be utilised at field boundary crossings where possible to minimise impacts on existing vegetation.

2b.7.10 Creating the construction access would form part of the substation enabling works and will take approximately 4-6 weeks. During this time temporary construction access would need to be via the existing farm track from Bob Lane, which will eventually become the permanent operational access. Therefore Bob Lane will initially be used for the delivery of plant, cabins and materials to enable work on the new construction access. The construction works have been phased in this way to ensure that traffic movements along Bob Lane would be minimised as far as possible until the new construction access is in use.

2b.7.11 To create the construction access topsoil will be stripped and stored adjacent. The topsoil will be stored for the duration of the works and be sufficiently protected. Following completion of the works the construction access will be removed and the private land reinstated to a standard agreed with the landowner and the relevant local authority.

2b.7.12 The largest items of equipment that will be delivered to the site will be the Super Grid Transformers (SGTs). To transport the SGT to the substation site, the vehicle will have to proceed along Wineham Lane, turning left into the newly created bellmouth at the entry to the private land and onto the construction access entering the substation site. The delivery of these large loads will be timed to minimise impacts to other road users.

Operational Access

2b.7.13 The largest vehicles requiring access to the substation site will be during the construction phase, hence, a dedicated construction access is being proposed. During routine operation of the substation LGVs (e.g. transit vans) would typically be the largest vehicles accessing the site. The main access to the substation site during operation will be via the existing track located to the east of Twineham Court Farm from Bob Lane and Wineham Lane. The track will be upgraded to ensure it is of a suitable standard for operational traffic. During operation, traffic to the site will be minimal and are expected to be infrequent.

2b.8 Onshore Substation Construction

2b.8.1 The onshore substation construction will be split into six distinct phases (more information is set out under the subheadings below):

- Pre-construction activities;
- Enabling works;
- Site establishment and laydown areas;
- Earthworks and grading;
- Main civil and electrical works; and
- Commissioning.

Pre-construction activities

2b.8.2 Prior to the commencement of the substation works, a number of pre-construction surveys and studies will be carried out to inform the final design. These studies will not require any large vehicle movements. The surveys include:

- Ecological pre-construction surveys;
- Site investigations (including geotechnical and geophysical surveys);
- Thermal resistivity survey; and
- Drainage surveys.

Enabling works

2b.8.3 Ahead of the main substation construction works the new construction access, described above, will be established. This is expected to take between 4 and 6 weeks. The following will be required to facilitate this:

- Deliveries and storage of hardcore to establish the site compound and construction access route to it;
- Secure site compound, containing temporary construction management office, welfare facilities, fuel storage area and car park; and
- Deliveries of materials, plant, machinery and fuel.

2b.8.4 Bob Lane will be used initially during the enabling works to facilitate the construction of the temporary construction road and secure site compound. The aim would be to phase construction works in this way to minimise as far as possible the traffic that would need to access the site via Bob Lane during this initial period.

Site establishment & laydown areas

2b.8.5 Once the construction access has been created the main construction activities can begin. Site establishment and lay down areas will be required during construction of the substation which includes the following:

- Construction management offices;
- Mess facilities;
- Washroom facilities;
- Car parking;
- Wheel washing facility;

- Workshops; and
- Secure storage areas.

2b.8.6 Indicative site establishment and laydown areas are identified in the substation layout on Figure 2b.15.

Temporary Fencing

2b.8.7 Temporary fences will be erected along the boundaries of the substation site for the duration of the construction period.

Grading & earthworks

2b.8.8 Land levels at the substation site vary in excess of 8m. Re-profiling will be required to provide a flat construction platform. Alternatively the substation site might be constructed in tiers to minimise earthworks. During final engineering, a slope percentage will be selected that results in the least amount of earth movement while meeting the physical requirements of the substation.

2b.8.9 Prior to the start of grading, the entire area to be graded will be stripped of all vegetation. Any waste material encountered will be removed as required by the pre-construction surveys and investigations. Once the surface has been cleared, the grading operations will begin.

2b.8.10 If it proves impossible or impractical to balance the earthwork quantities, it may be necessary to either export excess soil or import new fill soil. Any contaminated soil will be disposed of at a licensed disposal site. Excavations of foundations and trenches would commence following the completion of grading

Main civil and electrical works

2b.8.11 The civil works will include the construction of:

- Foundations for the buildings;
- Foundations for outdoor electrical equipment;
- Control & switchgear buildings, offices, stores and other ancilliary buildings;
- Site roads and hardstandings;
- Security fencing and access gates;
- Cable trenches;
- Ducts and pits;
- Substation drainage systems; and

- Provision of utility supplies.

2b.8.12 Standard building techniques will be utilised for construction of the OFTO and E.ON control buildings. Pending detailed design piled foundations could be required.

2b.8.13 Impermeable areas, e.g. the control and ancillary buildings within the site, will require permanent surface drainage. Discharges will be routed to a suitable watercourse or soakaway in the absence of a local authority sewer (dependant on ground permeability).

2b.8.14 Where discharges arise from areas where there is a risk of oil contamination, e.g. the access road, transformer areas, reactive compensation enclosures and car parking, such discharges will be routed via a Class 1 oil separator in compliance with BS EN 858. Discharge consents will be applied for through the appropriate statutory authority. Further details are provided in Section 23 (Surface Water Hydrology and Flood Risk).

2b.8.15 The preferred method for controlling foul waste will be determined during detailed design and will depend upon the availability and cost of a mains connection and the number of visiting hours staff would attend site.

2b.8.16 The electrical works will include the delivery, assembly and installation of all electrical equipment, switchrooms, cables, gantries and control systems and the connection of such. Electrical equipment containing oil will be installed in a bunded area constructed from concrete.

Fire Walls and Oil Containment

2b.8.17 Electrical equipment containing oil will be installed in a bunded area constructed from concrete. Firewalls may be erected and these would have approximate dimensions no greater than 22m long by 9m high.

Commissioning

2b.8.18 Once the substation construction is complete a period of commissioning is required to ensure that mechanical, electrical and other building systems are installed, tested, and perform in accordance with the approved design. This systematic process provides verification that systems are functioning properly, as designed.

2b.9 Onshore Substation Construction Programme and Delivery

Programme

2b.9.1 It is anticipated that the onshore substation construction works are expected to be completed within approximately 24 months, although they may be influenced by seasonal variations but should not exceed a 28 month window in total.

Construction Plant

2b.9.2 Table 2b.6 outlines the estimated heavy vehicle movements entering the site during the construction phase of the substation. The types of heavy vehicles that will be accessing the site are likely to include:

- Rigid lorries;
- Articulated lorries;
- Tractors and trailers;
- Articulated dump Trucks;
- Low loaders; and
- Cranes.

Table 2b.6: Estimate of heavy vehicles entering the substation site during construction

Activity	Description	Approximate no. of heavy vehicle deliveries	Max deliveries in 1 day
Enabling Works (access via Bob Lane)	Early site set up and construction of new access road	160	16
Site Establishment	Delivery of site cabins, temp fencing, site services	865	23
Site Preparation	Delivery/collection of plant Removal of topsoil Delivery of road materials Delivery of fencing	210	7
Excavation & Foundations	Removal of excavated arisings Delivery of concrete	1,051	30
Site Building Works	Delivery of building materials	440	10
Other civils	Delivery of drainage pipes, kerbs, manholes, ducts	563	11
Site Surfacing	Delivery of stone chippings	700	5
Electrical Plant Installation	Delivery of components, cables and structures	482	17
Miscellaneous	Fuel deliveries, drainage, etc.	1,955	10
Total		6,266	See note

Note: The maximum HGVs (defined as vehicles greater than 12.5 tonnes) entering and exiting the onshore substation site in any one day is not expected to exceed 40 vehicles.

Workforce

2b.9.3 Table 2b.7 presents an estimate of the numbers of construction workforce for the substation based on a similar project. The numbers from month 1 are from the start of the site establishment works. Workforce numbers for pre-construction activities and enabling works are not included but they are not expected to exceed month 1 of the construction estimates below.

Table 2b.7: Estimate of Construction Workforce

	Year 1		Year 2	
Month	**Man-Hours**	**Workforce**	**Man-hours**	**Workforce**
1	4,000	61	2,000	31
2	12,800	194	2,900	44
3	12,800	194	2,900	44
4	12,800	194	2,900	44
5	12,800	194	4,100	63
6	12,800	194	15,700	238
7	13,600	207	16,500	250
8	13,600	207	14,400	219
9	8,800	134	8,800	134
10	8,800	134	4,000	61
11	4,000	61	2,000	31
12	4,000	61	1,000	16

2b.9.4 From the table above it can be deduced that the total estimated manhours over a two year period will be 198,000, with a peak workforce not expected to exceed 250 personnel.

2b.10 Operation, Maintenance and Decommissioning

Onshore Cable Route

Operation and Maintenance

2b.10.1 The onshore cable will be predominantly maintenance free. Access will be required to the link boxes approximately every 2 to 5 years by a cable engineer in order to test the cable oversheath.

2b.10.2 Within the 15m permanent easement, the operator has the right to construct, maintain, repair and inspect the cable. This will not affect land in agricultural use, although conditions will be attached restricting certain activities to ensure that there is no accidental damage to the cable. Typically, such restrictions preclude the erection of buildings and the planting of trees. Such restrictions have been included in landowner agreements.

2b.10.3 All inspections and routine maintenance will follow best practice procedures and be in accordance with the relevant standards at that time.

Decommissioning

2b.10.4 At decommissioning it is anticipated that the onshore cables will be left buried in situ, unless lifted to be replaced by new cables to be run along the same route as part of future developments or wind farm repowering.

2b.10.5 Details of the decommissioning of the cable route will be investigated in detail towards the end of its service life. It is likely that ducting will remain in place; however, the cables may be pulled out of the ducts via the jointing bays.

Onshore Substation

Operation and Maintenance

2b.10.6 The substation site will be designed to be unmanned during normal operation. The site is likely to have a perimeter of security fencing and CCTV will be installed to give remote observation capability 24 hours a day. Permanent light fittings will be installed around and within the substation. Under normal operating conditions the substation will not be illuminated at night. Lighting will be used only when required for maintenance outages or emergency repairs occurring at night. The lights will be directed downward, and shielded to reduce glare outside the facility.

2b.10.7 There will be a requirement for staff to access the site occasionally for landscaping (e.g. grass cutting, weeding, etc.) or other minor operational activities. Electrical plant may require infrequent visual inspection and minor servicing depending on manufacturer requirements, but largely the substation will require little in the way of scheduled maintenance activities. Unscheduled maintenance may also be required but this is expected to be infrequent. Maintenance activities will be carried out by personnel accessing the site in LGVs.

Substation Decommissioning

2b.10.8 No decision has been made regarding the final decommissioning policy for the proposed substation, as it is recognised that industry best practice, rules and legislation change over time. The onshore substation may continue to be used as a substation site after the Project has been decommissioned. It is possible that the substation will be upgraded for use by future offshore renewable developments. The decommissioning methodology cannot be finalised until immediately prior to decommissioning; the substation will be decommissioned in line with relevant policy at that time.

2b.11 Onshore Cable and Substation Electromagnetic Fields

Background

2b.11.1 An issue that is often raised in relation to high voltage underground cables, electricity substations and other significant electrical installations is that of exposure to Electromagnetic Fields (EMFs).

2b.11.2 EMFs arise from electric charges and the strength of a field at a point depends upon the distribution and behaviour of the charges involved. Examples of electromagnetic fields include static fields such as the Earth's magnetic field and fields from electrostatic charges, electric and magnetic fields from the electricity supply at power frequencies (50Hz in the UK), and radio waves from TV, radio and mobile phones, radar and satellite communications (typically many million Hz).

2b.11.3 Electric fields are dependent on the operating voltage of the equipment at any one time. As the operating voltage of the wind farm will be generally constant, the electric fields produced will be virtually constant.

2b.11.4 Magnetic fields are dependent on the electrical current flowing in the system at any given time, which will vary with the output of the wind farm.

2b.11.5 Substations and overhead lines produce both electric and magnetic fields. Underground cables do not produce any external electric fields.

National Guidance

2b.11.6 The Government sets guidelines for exposure to EMFs in the UK on advice from the Health Protection Agency (HPA). In March 2004 the UK adopted the 1998 guidelines published by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

2b.11.7 The ICNIRP ‘reference levels’ for the public are:

- 100 microteslas (µT) for magnetic fields (Tesla (T) is the unit of measurement for magnetic fields);
- 5 kilovolts (kV) per metre for electric fields.

2b.11.8 These are the levels above which more investigation is required if this level of exposure is likely to occur; the permitted levels of exposure are somewhat higher, 360 microteslas and 9,000 volts per metre. They apply where the time of exposure is significant. The occupational limits are five times higher.

EMFs from the Transmission of Electricity

EMFs at Substations

2b.11.9 The Health Protection Agency’s Radiation Protection Division (HPA RPD) provides advice on standards of protection for exposure to non-ionising radiation, including the extremely low frequency (ELF) EMFs arising from the transmission and use of electricity. In March 2004, the National Radiological Protection Board (NRPB), now the HPA RPD, surveyed representative local area substations in order to characterise magnetic fields along enclosure boundaries. In all cases, at distances varying between 5m and 10m from the boundary fence, magnetic fields due to substations were undetectable above between 0.02 and 0.05

microteslas; levels typical of low household magnetic fields associated with the electricity supply system. Along the path of cables and lines, magnetic field strengths of up to 1 microtesla were measured.

2b.11.10 A National Grid Company survey (Renew, Male & Maddock, 1990) of suburban substations, with measurements taken at 0.5m above ground level within 1m of enclosures, revealed mean magnetic flux densities of about 1.9 microteslas falling by a half over an average distance of 1.3m, and in the vicinity of housing becoming indistinguishable from the background due to other domestic sources within 5m.

2b.11.11 Electric field strength measurements close to local area substations indicate that electric field strengths are often below 1 volt per metre and this is attributed to the shielding provided by the metallic casing on components and cables, and to the enclosure walls. Only where overhead feeder lines occur, are electric fields likely to exceed a few volts per metre. Up to a few tens of volts per metre have been measured beneath associated high voltage supply lines; circuit configurations which are generally rare.

EMFs from Underground Cables

2b.11.12 Cables are typically installed 1m below ground, compared to an overhead line where the conductors are typically more than 10m above ground, so the magnetic field directly above a cable is usually higher than that directly below the equivalent overhead line. However, as the individual cables are installed much closer together than the conductors of an overhead line, this results in the magnetic field from cables falling more quickly with distance than the magnetic field from overhead lines. Overall, then, directly above the cable and for a small distance to the sides, the cable produces the larger field; but at larger distances to the sides, the cable produces a lower field than the overhead line.

2b.11.13 Due to the metallic shielding present around the cable insulation, no external electric fields are produced by underground cable. Table 2b.8 illustrates this fact for measurements taken of a 132kV underground cable.

Table 2b.8: Actual Field Values for a 132kVkV Cable

			Magnetic Fields in µT at distance from centreline (132kV Cable – 1m depth) operating at 50Hz			
			0 m	5 m	10 m	20 m
Direct Buried	Laid separately (0.5m spacing)	Typical	9.62	1.31	0.36	0.09
	Laid in trefoil	Typical	5.01	1.78	0.94	0.47

Notes:

ICNRP reference limit for public exposure to magnetic fields is 100µT

All fields calculated at 1m above ground level.

Fields are for a single circuit. Laying a number of circuits adjacent to each other will result in some field Magnetic Field strength will vary with current, therefore field strength at any one time will depend on wind farm output.

2b.11.14 The electric and magnetic fields from all National Grid substations, overhead lines and underground cables comply with the relevant exposure limits, adopted by UK Government on the advice of the Health Protection Agency.

2b.11.15 The ICNIRP independent exposure guidelines, together with a Code of Practice, adopted jointly by industry and Government to sets out all the practical details needed to apply exposure limits, will be followed for all elements of the works.

2b.12 References

Energy Networks Association, "Electric and Magnetic Fields, the facts", January 2012

National Grid, "Underground high voltage electricity transmission – the technical issues", Cited Jun-2012, http://www.nationalgrid.com/NR/rdonlyres/A7B84851-242F-496B-A5E8-697331E15504/36546/UndergroundingTheTechnicalIssues5.pdf

Health Protection Agency, "Electricity Substation and Power Lines", Cited Jun-2012, http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/ElectromagneticFields/ElectricitySubstationsAndPowerLines/

Renew, D C, Male, J C and Maddock, B J. Power-frequency magnetic fields: Measurement and exposure assessment. 36–105, CIGRé, 1990 Session, Paris (1990).

"Electric and Magnetic Fields", Cited Jun-2012, http://www.emfs.info/Sources+of+EMFs/Substations/National+Grid+substations/

Rampion Offshore Wind Farm

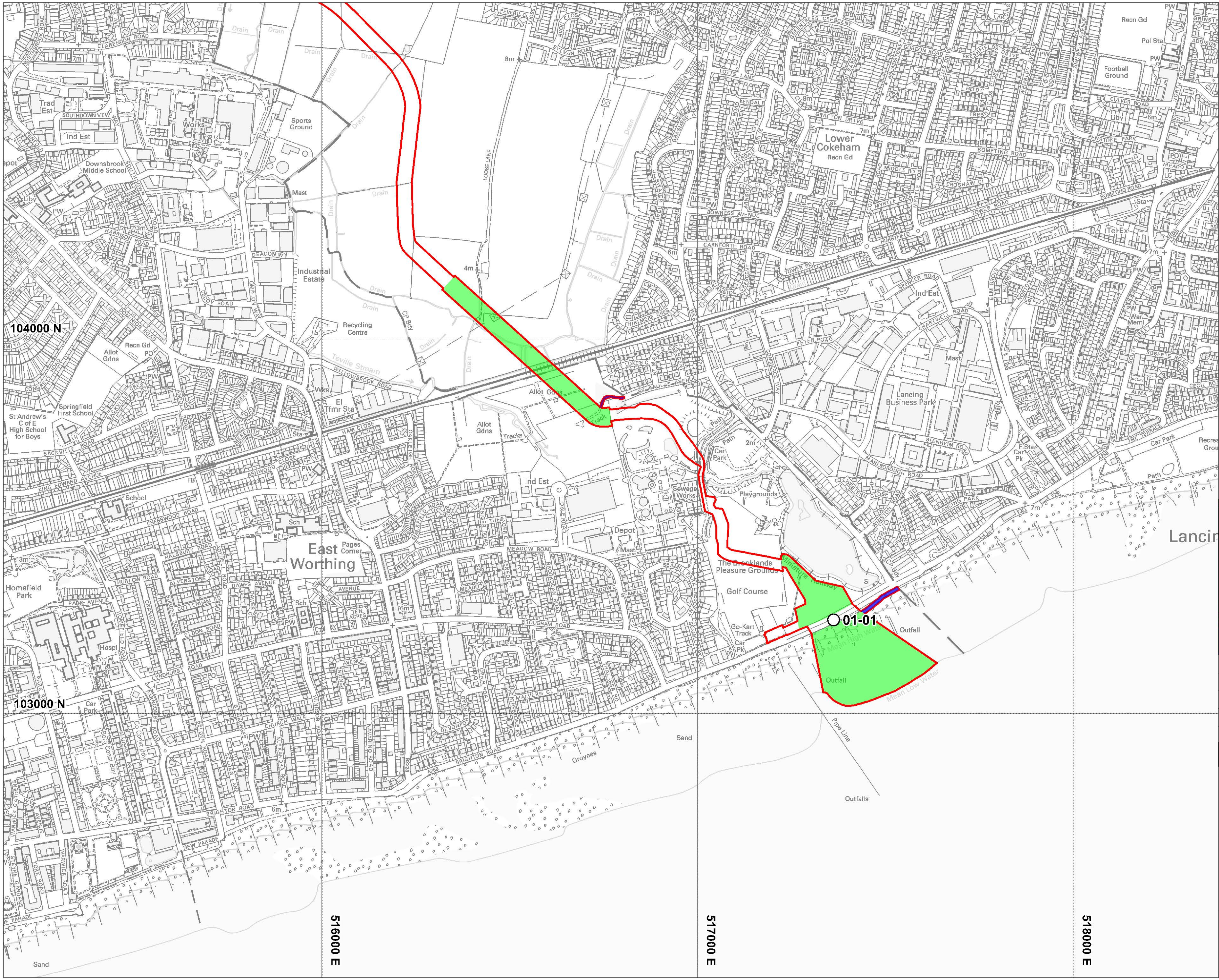
ES Section 2b – Onshore Project Description Figures

RSK Environmental Ltd **Document 6.2.2b**

December 2012 **APFP Regulation 5(2)(a)**

Revision A

E.ON Climate & Renewables UK Rampion Offshore Wind Limited



Legend :

- Development Area
- HDD Section
- Side Access
- Temporary Construction Compound
- Crossing Number

Rev	Date	Description	Drn	Chk	App
02	22.11.12	New Development Area	AJ	KB	DW
01	15.11.12	Crossings Added	AJ	KB	DW
00	30.10.12	First Draft	AJ	KB	DW

Rampion Offshore Wind Farm

RSK e·on

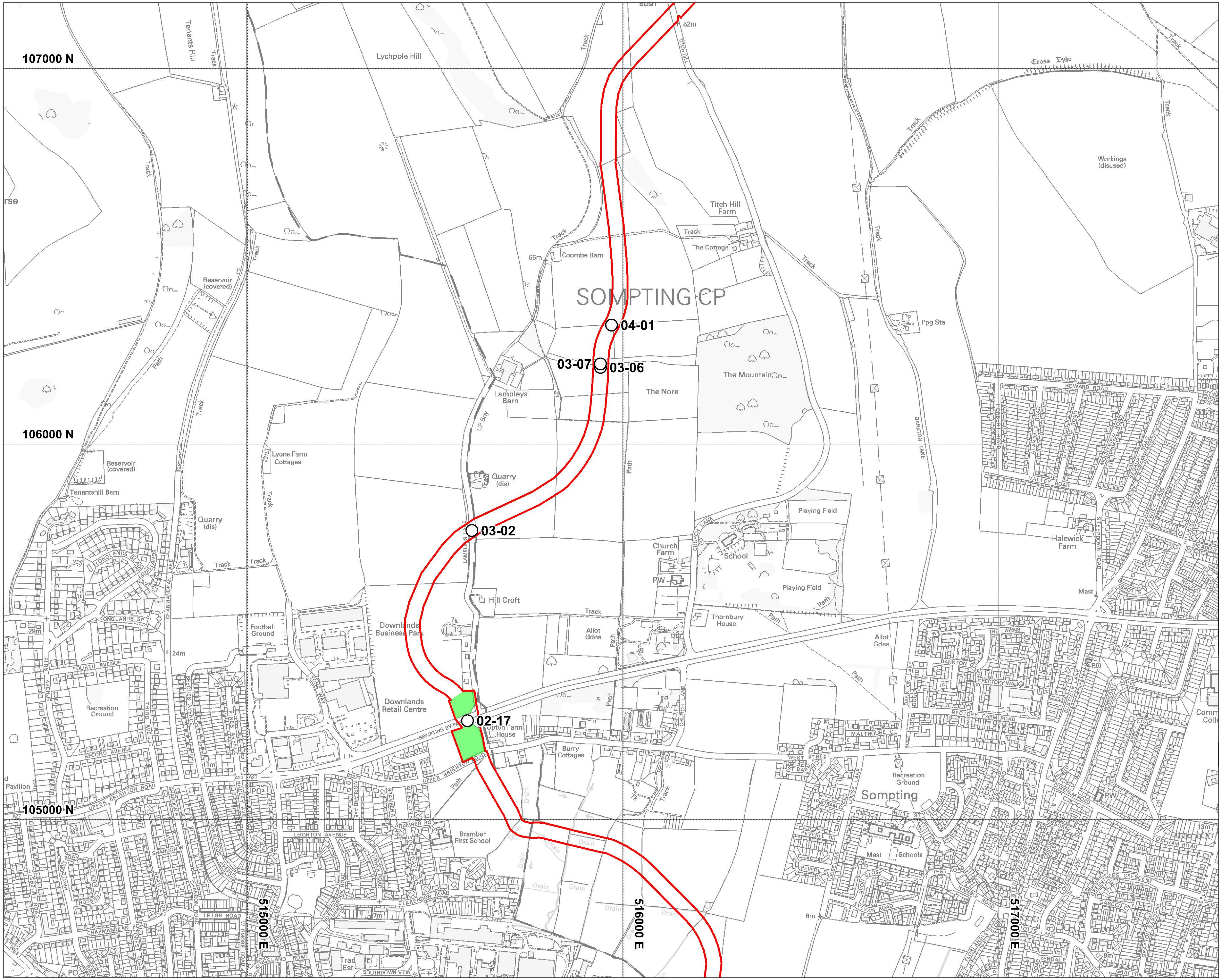
Title :

Figure 2b.1:
Onshore Development Area
(Map 1 of 9)

0 150 300
Metres
Scale = 1:10,000 @ A3

REV 02

FILE NAME: \P41318 - Rampion Offshore Wind Farm\05 - GIS\ES_Fig 2b.1 Onshore Development Area 01.wor



Legend :

- Development Area
- HDD Section
- Side Access
- Temporary Construction Compound
- Crossing Number

Rev	Date	Description	Drn	Chk	App
02	22.11.12	New Development Area	AJ	KB	DW
01	15.11.12	Crossings Added	AJ	KB	DW
00	30.10.12	First Draft	AJ	KB	DW

Rampion Offshore Wind Farm

RSK e·on

Title :

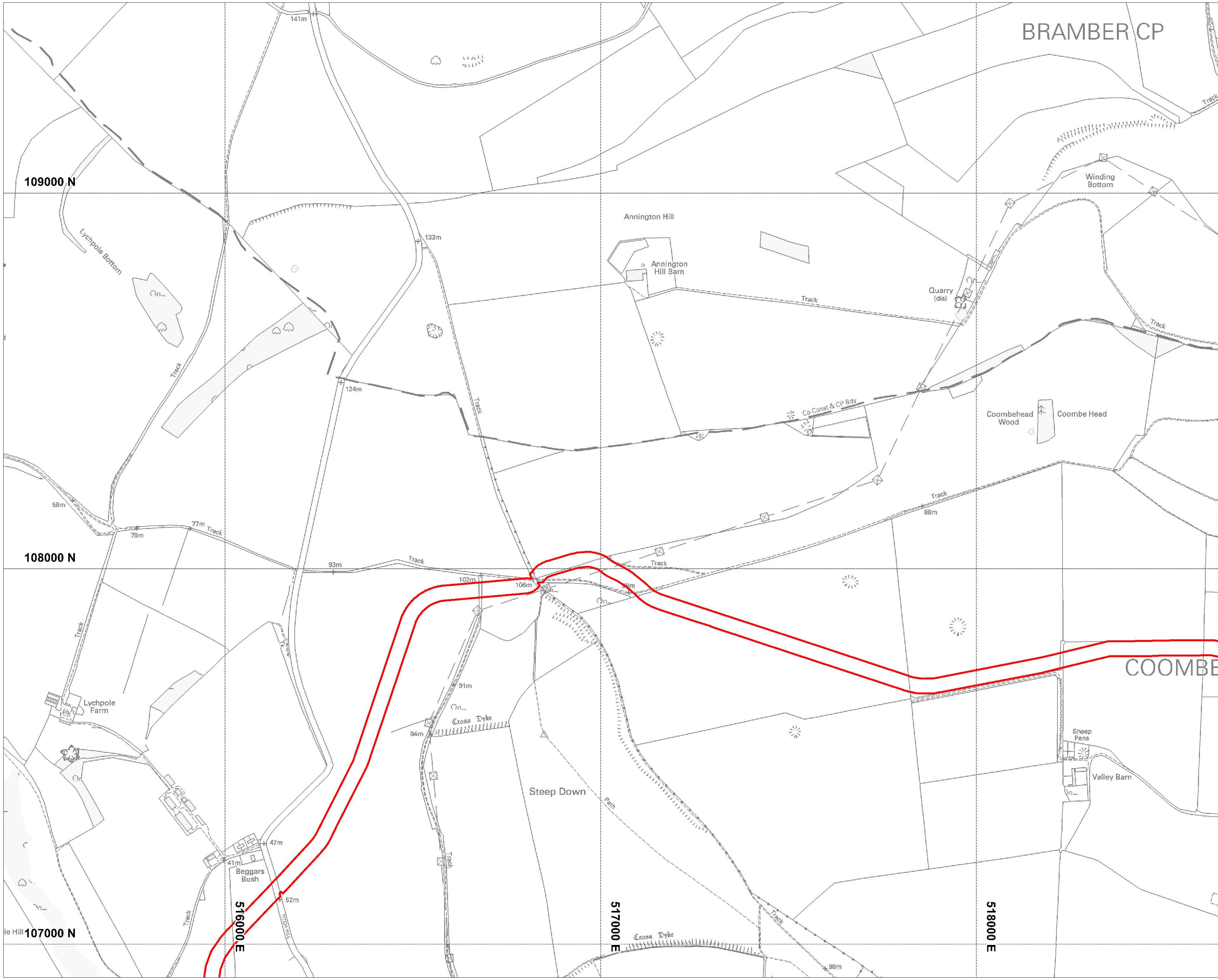
Figure 2b.1:
Onshore Development Area
(Map 2 of 9)

0 150 300
Metres
Scale = 1:10,000 @ A3

N W E S

REV 02

FILE NAME: \P41318 - Rampion Offshore Wind Farm\05 - GIS\ES_Fig 2b.1 Onshore Development Area 02.wor



Legend :

- Development Area
- HDD Section
- Side Access
- Temporary Construction Compound
- Crossing Number

Rev	Date	Description	Drn	Chk	App
02	22.11.12	New Development Area	AJ	KB	DW
01	15.11.12	Crossings Added	AJ	KB	DW
00	30.10.12	First Draft	AJ	KB	DW

Rampion Offshore Wind Farm

Title :

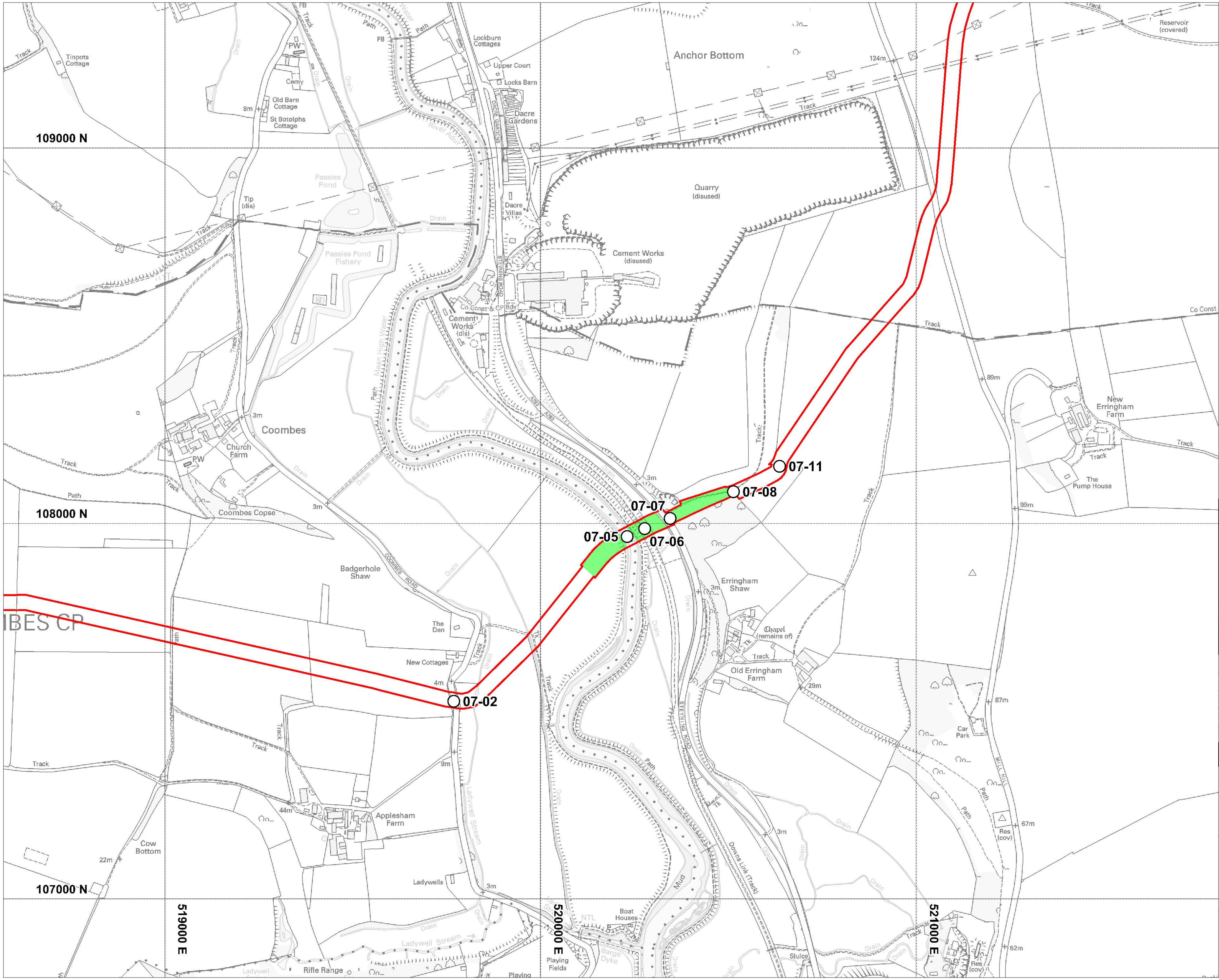
Figure 2b.1:
Onshore Development Area
(Map 3 of 9)

0 150 300
Metres
Scale = 1:10,000 @ A3

N W E S

REV 02

FILE NAME: \P41318 - Rampion Offshore Wind Farm\05 - GIS\ES_Fig 2b.1 Onshore Development Area 03.wor



Legend :

- Development Area
- HDD Section
- Side Access
- Temporary Construction Compound
- Crossing Number

Rev	Date	Description	Drn	Chk	App
02	22.11.12	New Development Area	AJ	KB	DW
01	15.11.12	Crossings Added	AJ	KB	DW
00	30.10.12	First Draft	AJ	KB	DW

Rampion Offshore Wind Farm

RSK e·on

Title :

Figure 2b.1:
Onshore Development Area
(Map 4 of 9)

0 150 300
Metres

Scale = 1:10,000 @ A3

REV 02

FILE NAME: \P41318 - Rampion Offshore Wind Farm\05 - GIS\ES_Fig 2b.1 Onshore Development Area 04.wor

Rampion Offshore Wind Farm

ES Section 2b – Onshore Project Description

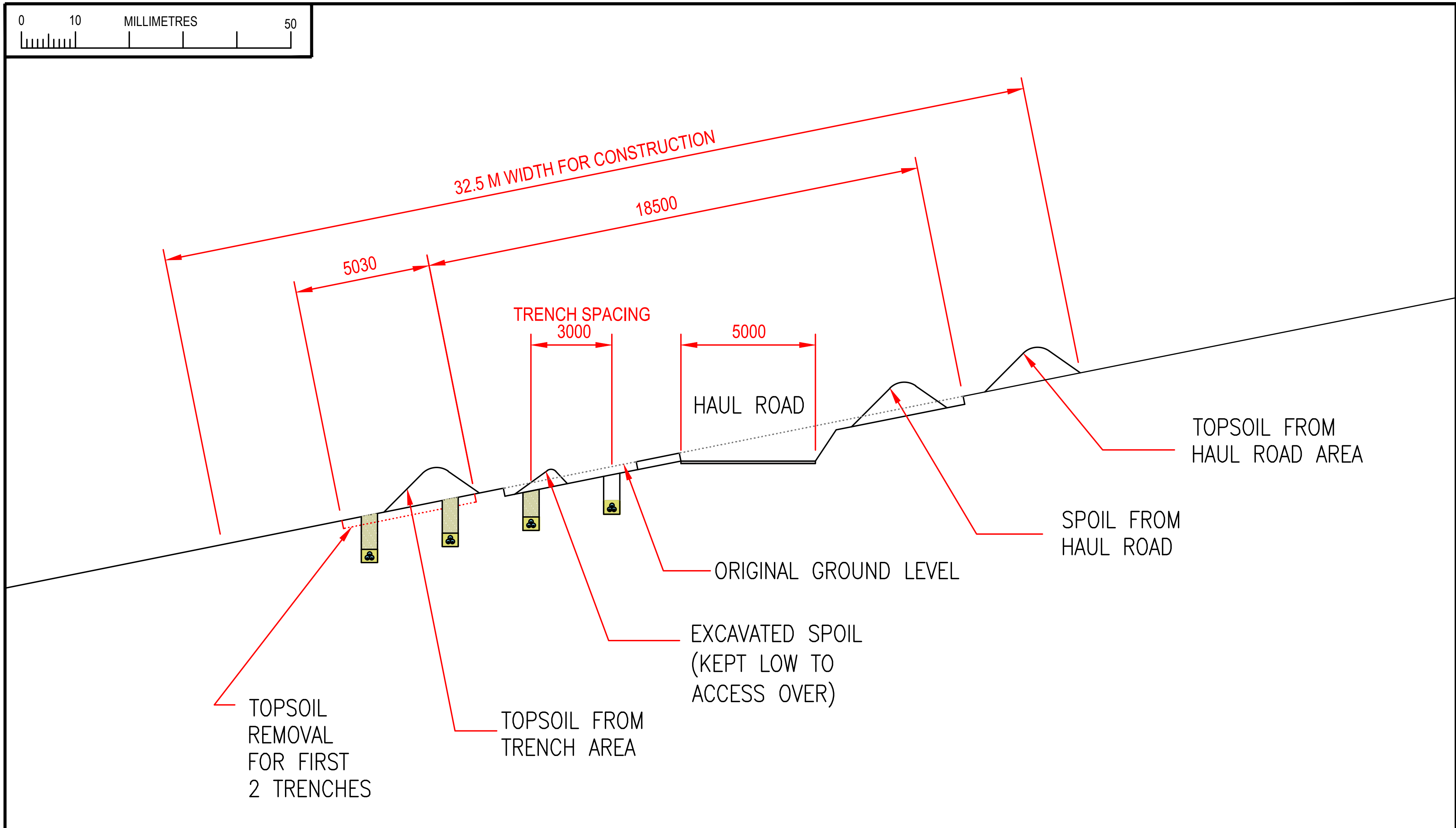
Appendix 2b.1

E.ON Climate & Renewables **Document 6.3.2b.i**

December 2012 **APFP Regulation 5(2)(a)**

Revision A

E.ON Climate & Renewables UK Rampion Offshore Wind Limited



Dimensions in mm (Unless stated otherwise)

ATKINS

Atkins Limited
Woodcote Grove
Ashley Road
Epsom, Surrey
KT18 5BW
England

Telephone +44(0)1372 726 140
Fax +44(0)1372 740 055

CLIENT: e·on

PROJECT: EON RAMPION

TITLE: TOTTINGTON MOUNT ENGINEERING SECTION 1

SCALE:	ORIGINAL SIZE:	ORIGINATOR:	CHECKED:	REVIEWED:	AUTHORISED:
1:200	A4	IC			
	OFFICE: GLASG	DATE: 24-10-12	DATE:	DATE:	DATE:
Project No: 5107085		Discipline: CL	Type: DG	Number: 101	Status/Rev: B

File Reference: 5107085_CL-DG_101_Rev B

Rampion Offshore Wind Farm

ES Section 2b – Onshore Project Description

Appendix 2b.2

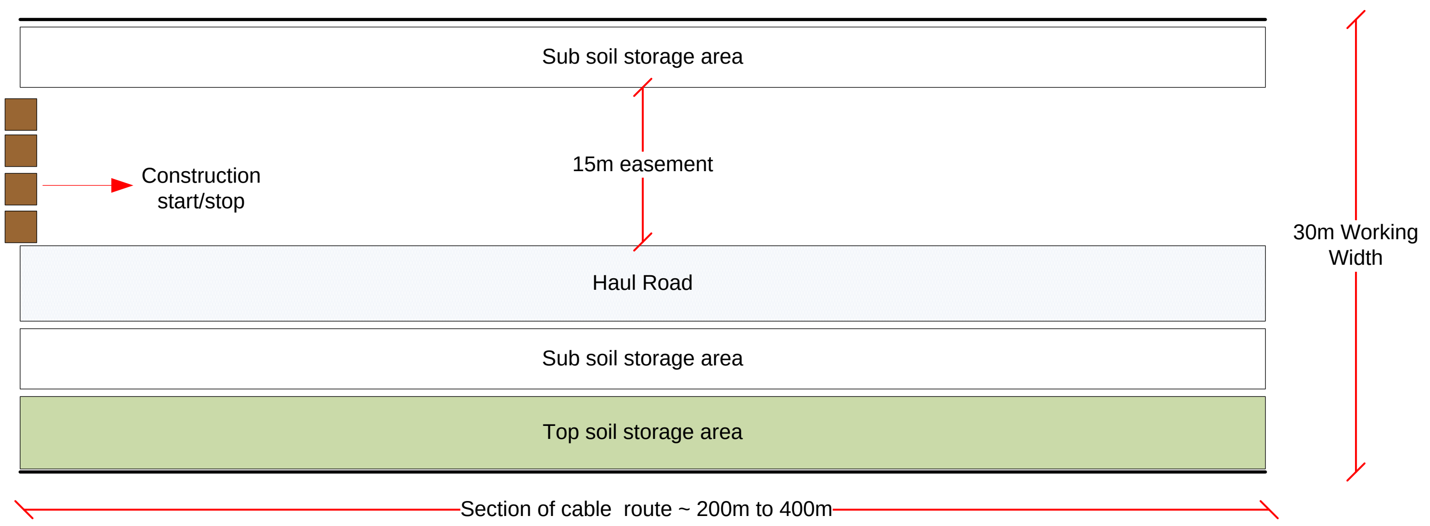
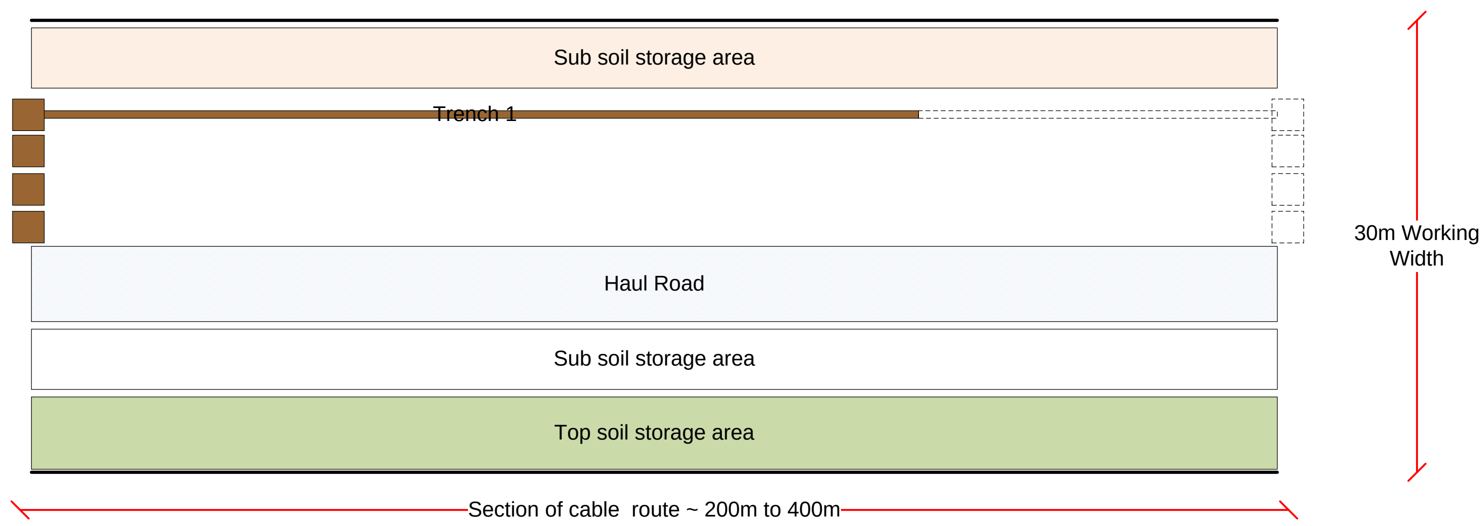
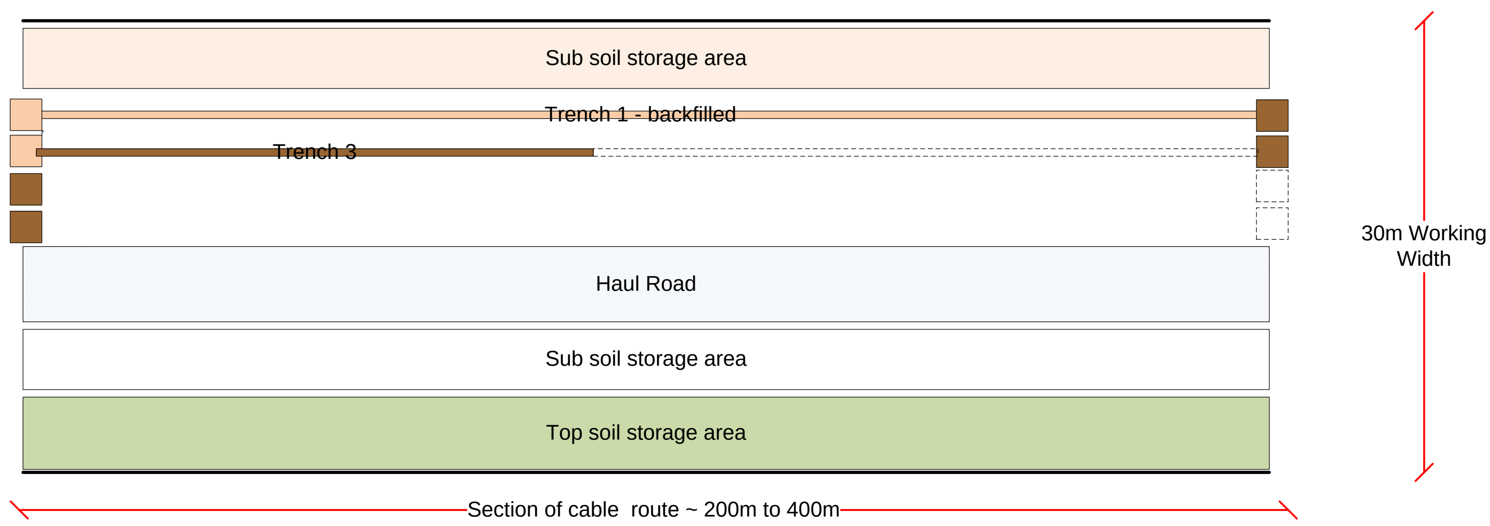
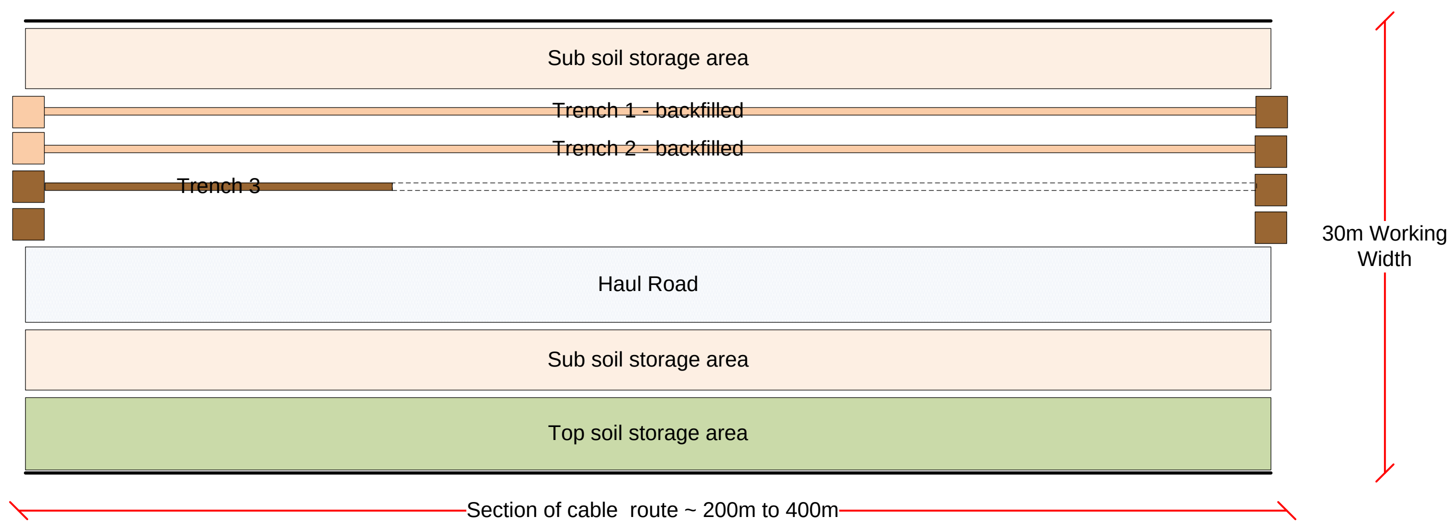
E.ON Climate & Renewables **Document 6.3.2bii**

December 2012 **APFP Regulation 5(2)(a)**

Revision A

E.ON Climate & Renewables UK Rampion Offshore Wind Limited

Appendix 2b.2 – Indicative trenching sequence

Description	Illustration
Figure 1 The figure on the right shows an illustrative plan of the nominal working width set up for trenching operations. The topsoil has already been stripped allowing for sub-soil storage areas, haul road, topsoil storage area and the easement along which the trenches will be excavated. The four brown boxes to the left of the illustration represent the end point of the previous days trenching operation and the start point for the next day's trenching operations.	
Figure 2 Trenching operations begin by re-opening the trenching construction start/stop points for the first of the four trenches. Sub soil is stored to the side as the excavator/s move along the trenches. As the excavator is working along the trench the ducting team will follow behind by laying the stabilized bedding material, laying and jointing the ducts and begin backfilling the trench along with installing the protective cover tiles and marker tape.	
Figure 3 When the first trench has been backfilled, excavation of the second trench can begin, followed by the installation of the stabilized bedding, the ducting, tiles and marker tape.	
Figure 4 Operations are repeated for the third and fourth trenches. The length of each construction operation per day will be approximately 200m and 400m depending on ground and weather conditions and the number of teams working on site.	

P:\GBEMF\Power\Offshore Renewables\Projects\5099062 - EON Rampion Engineering Services\10 - Service delivery\002 - Eng Support\70 - Trenching sequence sketch\Trenching sequence_v1-1.docx

Figure 5
When all four trenching operations are completed within that day's construction section, the subsoil material will be evenly spread across the easement and subsoil areas.

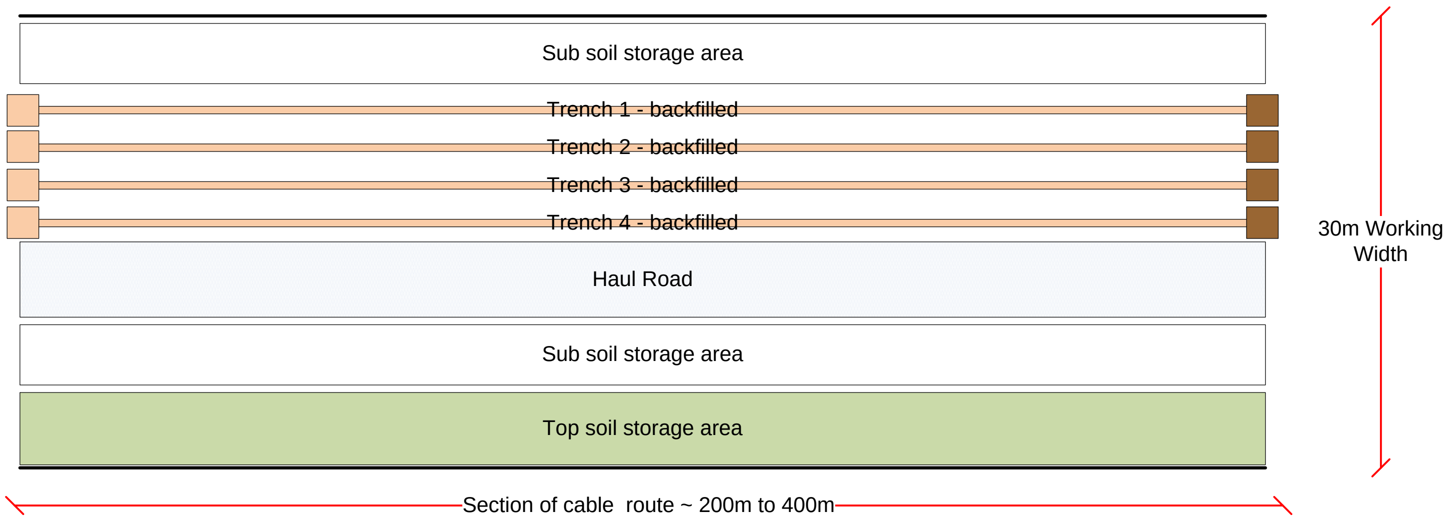
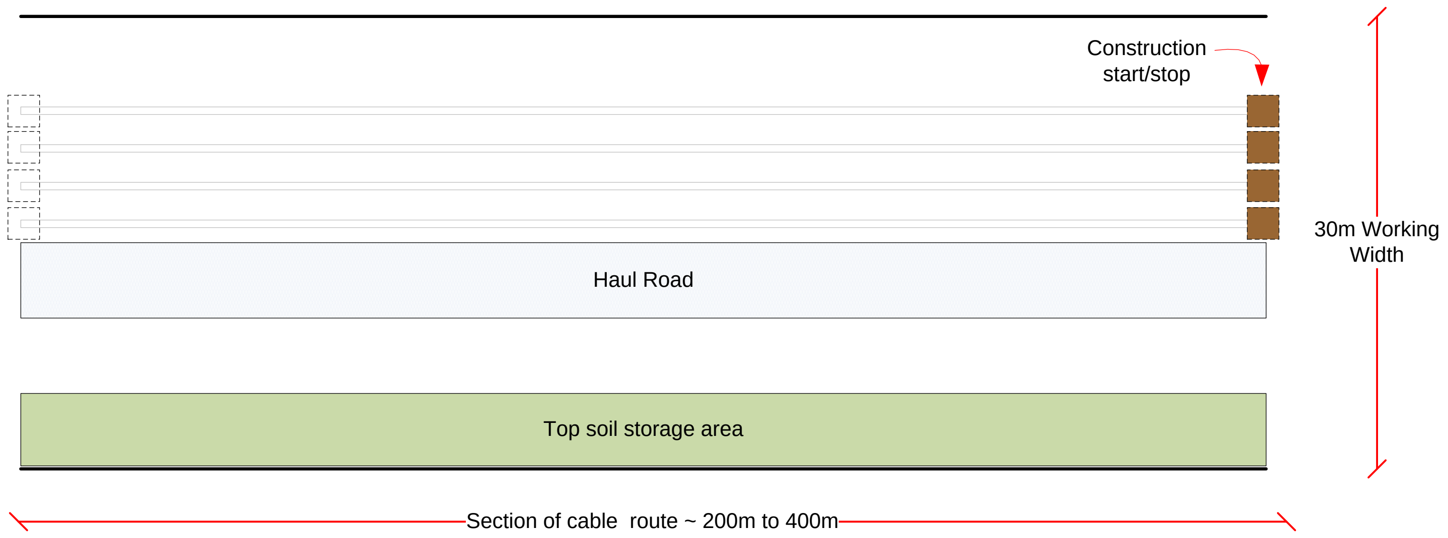
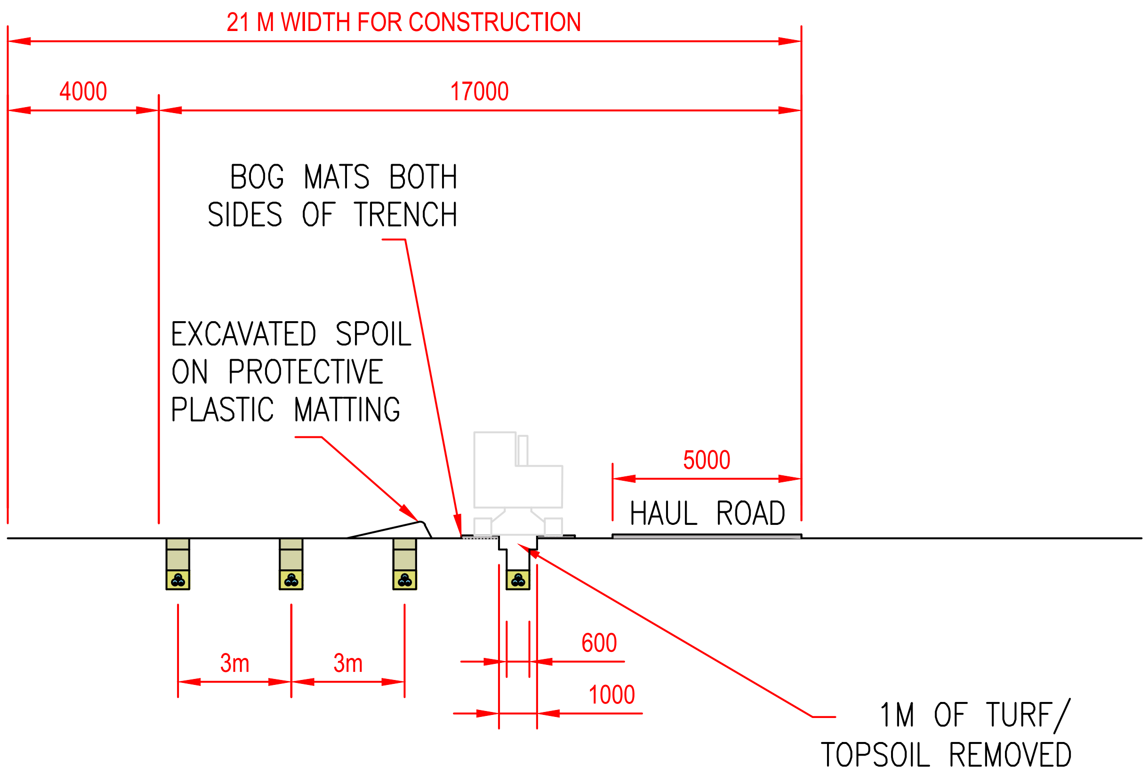


Figure 6
The construction start/stop point will be temporarily backfilled at the end of the day's operations and will be re-opened on the next day's trenching operation.

Top soil storage and haul road would remain in place until a larger section of trenching has been completed, e.g. between junction boxes and/or significant crossings.



0 10 MILLIMETRES 50



Dimmensions in mm (Unless stated otherwise)

ATKINS

Atkins Limited
Woodcote Grove
Ashley Road
Epsom, Surrey
KT18 5BW
England

Telephone +44(0)1372 726 140
Fax +44(0)1372 740 055

CLIENT: e·on

PROJECT: EON RAMPION

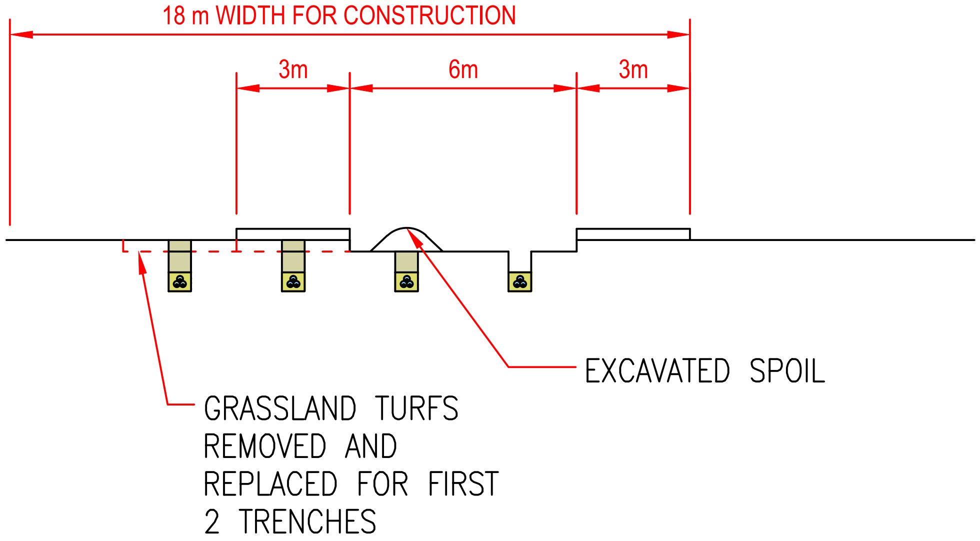
TITLE: TOTTINGTON MOUNT ENGINEERING SECTION 2

SCALE:	ORIGINAL SIZE:	ORIGINATOR:	CHECKED:	REVIEWED:	AUTHORISED:
1:200	A4	IC			
	OFFICE: GLA	DATE: 24-10-12	DATE:	DATE:	DATE:

Project No:	Discipline:	Type:	Number:	Status/Rev:
5107085	CL	DG	102	B

File Reference: 5107085_CL-DG_102_Rev B

0 10 MILLIMETRES 50



ATKINS

Atkins Limited
Woodcote Grove
Ashley Road
Epsom, Surrey
KT18 5BW
England

Telephone +44(0)1372 726 140
Fax +44(0)1372 740 055

CLIENT: e·on

PROJECT: EON RAMPION

TITLE: TOTTINGTON MOUNT ENGINEERING SECTION 3

SCALE:	ORIGINAL SIZE:	ORIGINATOR:	CHECKED:	REVIEWED:	AUTHORISED:
1:200	A4	IC			
	OFFICE: GLA	DATE: 24-10-12	DATE:	DATE:	DATE:

Project No:	Discipline:	Type:	Number:	Status/Rev:
5107085	CL	DG	103	B

File Reference: 5107085_CL-DG_103_Rev B